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ACCIDENT ON BOARD H.M.S. COLLINGWOOD.

THE Collingwood, named after the "brave old Collingwood," Nelson's bosom friend, and his second in command at Trafalgar, was launched in 1882, at Pembroke Dockyard, and her fittings completed at Portsmouth. Recently she left the port, anchored at Spithead, where she took in powder and shot, and on the following day weighed anchor and proceeded to Sandown Bay, where the trials were to have taken place, but unfortunately an accident of a very serious character marred the programme at the initial stage. The two large guns on the after tower were first "scaled" with light blank charges, 73¾ lb.

The "right" gun, as it is termed, was then loaded and fired successfully, 221¼ lb. of powder being employed, the projectile consisting of a common shell filled with water. On the discharge of the sister gun (the left) every one about and below felt that something unusual was "up," and as the large volume of smoke cleared away it was discovered that the "chase" of the gun, eight feet from the muzzle, which was made of hard steel, was completely blown away, fragments of it being hurled in every direction, the greater portion falling into the sea about thirty yards distant. Fortunately, to every one's surprise, no one was hurt. One of the thick iron doors of the superstructure abaft the barbette tower was so shaken as to burst the iron bolt fastenings.

It will, perhaps, be difficult to discover the actual cause of the mishap. There is certainly no fault to find with the executive, which consisted of picked officers and men from the crews respectively of the Excellent, gunnery ship, and the flagship, Duke of Wellington. On examining the fracture no flaw could be discovered in the metal. What is most surprising, the charge was only a three-quarter one, the explosive substance in use being what is termed "cocoa" or brown powder, which is slower of combustion than ordinary black powder.

The experiments after the disaster, of course, were brought at once to a conclusion. It is difficult to describe the Collingwood; one can hardly call her a ship, as she has no sails; the proper term would be a floating steam battery. Her armament consists of four 43-ton breech loading guns, 27 ft. 4 in. long, supposed to be capable of carrying a shell nine miles; six 6 in. 4½-ton broadside guns, mounted on Vavasseur carriages; twelve Hotchkiss 6-pounders, ten Nordenfelts, and four Gardners.

The large guns are mounted on revolving tables, which are protected by towers 11¼ in. thick, the sides of which are sloping, forming a glacis. The guns, as seen in sketch No. 2, are loaded from below as a protection for the man while charging. They are run back from the firing position, B, about four feet, and depressed at the breech, as seen at A. A novel feature among the various fittings is the double fighting top.

The lower top is reached by means of a ladder within the center of the iron tubular mast, the upper one by means of the shrouds. "There is nothing new under the sun," for as seen in sketch No. 3, fighting tops were in vogue hundreds of years back, the subject being taken from an old engraving illustrating a ship of the thirteenth century.

The Collingwood is 325 ft. in length, with a maximum beam of 67 ft. The hull has a belt of 18 in. armor from the deck to four feet below the water line The superstructure (the portion painted lighter in the sketch) is a mere shell, within which are the broadside guns.

The Collingwood is the first of the Admiral class, and there can be no doubt that the fittings of her sisters will undergo alterations after this, the first, experiment.

1. General View of the Ship. 2. The Large Guns on the Revolving Table (A shows the gun lowered for reloading; B shows the gun in firing position. The mark + shows where the accident occurred to the gun at the recent trial). 3. "There is nothing new under the sun"—A Ship of the Thirteenth Century, showing the Ancient Use of "Fighting Tops," which are a Special Feature in the Collingwood.

THE BRITISH WAR SHIP COLLINGWOOD.

THE GREAT EASTERN STEAMSHIP.

AT 2 P.M. on Sunday, May 2, the Great Eastern steamship dropped anchor in that part of the river Mersey known as the Sloyne. The voyage from Milford presented much that cannot fail to attract our readers. The Great Eastern may be said to belong to a past generation. Her performance, indeed, had in it something of that interest which we might take in the conduct of a Siberian mammoth loosed from the icy prison in which it had been bound for ages, and free once more to live and move and breathe and eat.

The circumstances under which the huge ship went to Liverpool are peculiar. Purchased by the London Traders, Limited, in which Mr. De Mattos is a principal partner, in order to be sent out to Gibraltar to be used as a coal hulk, it became necessary to remove her from Milford Haven—where she has lain for a dozen years—to some port having a dockable to hold her and cranes competent to lift out her paddle engines and boilers. Liverpool was the most suitable port, and to Liverpool she has gone.

In Liverpool is an extremely enterprising firm—Messrs. Lewis & Co.—with large branch establishments in Manchester and Sheffield. Messrs. Lewis possess the largest clothing "emporiums" in the world. They decided to utilize the Great Eastern from the time of her arrival in the Mersey until the 14th of October as a huge advertisement, and to this end chartered her for the time named from Mr. De Mattos. She is to be utilized for the display of popular attractions. A circus will probably be established in one of her cable tanks, which is no less than 75 ft. in diameter. A menagerie will be found in her saloons. Stalls for the sale of all manner of wares will be established on her decks. Her sides will be covered with vast posters, from among which Pears' soap will not, we may be certain, be absent.

At the end of the period we have named she will return into Mr. De Mattos' hands, and the work of conversion for Gibraltar will be proceeded with; unless, indeed, other counsels prevail, and the ship is converted into a cargo boat, which could be done at a comparatively moderate outlay, by razeeing her upper deck, compounding her screw engines, putting in new boilers, removing her cable tanks, and so on. It will be remembered that the Great Eastern was the first vessel to lay a successful telegraph cable between this country and America.

Recent work in the same direction has been done by the Faraday and the Hooper—or, as she is now called, the Silvertown. Both these vessels have found remunerative employment in carrying grain, and on one occasion the Faraday brought over the Atlantic not less thon 11,200 tons, which is, we believe, the largest cargo of corn ever carried. There would be nothing remarkable in the Great Eastern following the example thus set her. It may be worth while to say here that the stories which have been industriously circulated to the effect that the Great Eastern is nothing better than a rotten hulk, with her bottom made up in places of bricks and mortar, are entirely untrue. To all intents and purposes her hull is just as sound now as the day the ship was launched. Before she was allowed to go to sea, the Board of Trade surveyed her in Milford Haven, and the result of the survey, which occupied no less than two months, was that she was freely granted her certificate. The bricks and mortar referred to are bricks laid in cement in certain places to prevent water lying instead of finding its way to the bilges, a precaution specially necessary, because the floor of the ship is dead flat for a long way amidships.

The bottom of the ship is in an awful condition, covered with barnacles and sea-weed. No word-painting of any kind can give an adequate notion of her proportions. She must be seen in order that these may be understood. She is almost, if not altogether, the largest structure ever made by man of iron. A very few bridges and the St. Pancras Station are in one sense larger, but only in a sense. Her length on the load water-line is 680 ft., but her stern overhangs considerably. She is 82 ft. 6 in. beam and 58 ft. deep, or the height of a good five-story house. Her tonnage, builders' measurement, is 22,927, register tonnage 13,343. Her bunkers stow 10,000 tons of coal, and she can stow 6,000 tons of cargo besides. Her draught loaded is 30 ft. Her displacement would then be 27,384 tons. Her wetted surface, loaded, is 66,420 square feet, and the area of her water-line 39,829 ft. As to her construction, we condense the following particulars from a little work concerning her published several years ago. "The hull, of the ship is divided transversely into ten watertight compartments of 60 ft. each, the bulkheads having no openings whatever lower than the second deck, while two longitudinal walls of iron 36 ft. apart traverse 350 ft. of the length of the ship. Up to the water-mark the hull is constructed with an inner and outer skin 2 ft. 10 in. apart, each of ¾ in. plate., and between these, at intervals of 6 ft., run horizontal stringers. Besides the principal bulkheads, there is in each compartment a second intermediate bulkhead, forming the end of a coal bunker, and carried up to the main deck. There are no openings under the deep water line through the principal bulkheads, except two continuous tunnels, near the water line, through one of which the steam pipes pass, while the other is used as a communication between the screw and paddle engine rooms, a trap-door and a ladder about midway opening into the cabin of the chief engineer.

Every distinct plate employed in the construction of the hull was moulded beforehand to the exact shape required by the situation it was to occupy. About 6,250 tons of iron have been used in the construction of the hull, and 3,000,000 rivets. At the bottom these plates are 1 in. thick, in all other places ¾ in. The deck of the ship is double or cellular, after the plan adopted by Stephenson in the Britannia tubular bridge, and is formed of two ½ in. plates at the bottom and two ½ in. plates at the top, between which are webs which run the whole length of the ship. The upper deck runs flush and clear from stem to stern for a breadth of about 20 ft. on either side, thus affording two magnificent promenades just within the bulwarks.

These promenades are rather more than the eighth of a mile long. Four turns up and down either side of them exceed a mile by 256 ft. Between the two side promenades of the upper deck are low bulwarks, to which are fixed the skylights of the large saloons for passengers. These saloons are 42 ft. wide, the longest being 100 ft., and there are deck gangways connecting the side promenades between each of them.

The ship was originally propelled by two sets of engines—paddle and screw. The paddle engines are in perfect condition, as good indeed as the first day, and are magnificent specimens of Old World engineering. They consist of four oscillating cylinders 74 in. in diameter and 14 ft. stroke. The original paddles were 56 ft. in diameter, with floats 13 ft. long and 8 ft. wide; but both these wheels were carried away in a gale, because the ship was stopped to save a boat which was being dragged overboard by a rope which became entangled in the wheel. So long as the wheels were in motion they were safe; but one of them was smashed to pieces by the fourth or fifth sea which struck her after they stopped, and the other followed suit a little afterward. These wheels weighed 185 tons each. New wheels were made, much stronger and of smaller diameter, viz., about 50 ft., and narrower floats put on. These wheels are still on the ship. The weight of the engines is no less than 850 tons; they were the largest engines ever made at that time, and indeed it is doubtful if they are not the largest oscillating engines ever made, those of the Ireland, Holyhead mail steamer, having but two cylinders, as against four in Scott Russell's engines.

The screw engines were built by Messrs. James Watt & Co., and are in a sense even now the largest screw engines in the world. They have four horizontal cylinders 84 in. diameter and 4 ft. stroke. The crank shaft is 24 in. in diameter in the journals, and so is the screw shaft, in which, it is worth while to add, there is a flexible coupling in the tunnel. There are two thrust blocks, one before and one abaft the coupling, which consists of two huge cross pieces, one keyed on the end of one shaft and the other on the end of the other shaft, cod pieces on the end of one crosshead going into holes in the other crosshead.

Any of our readers who possess Bourne's "Treatise on the Marine Engine" will find the screw engines and paddle engines of the Great Eastern illustrated. The four cylinders of the screw engines lie on their sides, two and two, port and starboard. They have each two piston rods, and the starboard engines have each one connecting rod, while the port engines have two; so that there are three big ends on each crank pin. The cylinders are framed together across the ship in the most solid fashion possible. There are four jet condensers, one to each cylinder, placed two and two between the condensers. The propeller is four-bladed, 24 ft. in diameter and 44 ft. pitch., of cast iron, and weighs 35 tons.

Originally, the ship had 112 furnaces and five funnels, but about fifteen or sixteen years ago she had new boilers, and the number of furnaces was reduced to eighty and the funnels in number to four. These funnels look out of all proportion small to the size of the ship, being only 6 ft. in diameter; but they give an excellent draught, being 100 ft. high from the level of the grate bars to the top, the grate bars being over 40 ft. below the upper deck. The boilers are of the box type, loaded now to 18 lb. on the square inch. They were retubed not long since. Each boiler is double-ended, with five furnaces at each end, and there are two boilers and 20 furnaces in each stoke hole, and eight boilers in all—four for the paddle and four for the screw engines. The screw boilers are each 17 ft. 9 in. long, 13 ft. 9 in. high, and 17 ft. 9 in. wide. The paddle boilers are of nearly the same dimensions; but the paddle boilers have 3,200 tubes, and the screw 4,920 of somewhat less diameter. The plates are ⅝ in. thick. The smoke-boxes are sunk into the boilers, the fronts of which are accordingly flush from top to bottom when the smoke-box doors are shut.

Certain curious statements have been circulated from the first concerning the engines and boilers. Thus, it was stated that the screw engines used 6·08 lb of coal per indicated horse power per hour, and the paddle engines 3·12 lb. There is nothing like a decimal point for lending an appearance of truth to a statement. This is, notwithstanding the decimal points, quite untrue. There was no marked difference between the engines in economy of fuel. In like manner it has been said that the paddle engines used 123 tons per day and the screw engines 260 tons. As a matter of fact, the consumption has always averaged three tons per furnace per twenty-four hours, or for 112 furnaces 336 tons, instead of 383 tons; and so far as we can learn, she never burned 300 tons in twenty-four hours. For the eighty furnaces her consumption never exceeded 240 tons altogether.

There is considerable doubt concerning her actual indicated power, which varied much with the immersion, because both paddle and screw engines were locked up, the one by the great diameter of the paddle wheels, and the other by the extravagant pitch of the screw. It is stated, however, that the paddle engines indicated 3,679 and the screw engines 3,976 horse power.

As the paddle engines were not used on the run round to Liverpool, the lower floats having been taken off and the wheels secured, we need say nothing more about them, except that the designer was a consummate engineer. To Scott Russell the credit has been given. No doubt he indicated the principal features, but the name of the man who designed them in detail deserves to be rescued from oblivion. Can any of our readers say who he was? The screw engines are unquestionably a splendid job, but very much too heavy for the work they have to do. It appears that they never at any time made more than 36 revolutions per minute, which corresponds to a piston speed of only 288 ft. per minute. Had the pitch of the screw been reduced, the engines are quite strong enough and solid enough to run with ease at 50 revolutions, which would, after all, be only 400 ft. per minute; smaller cylinders would then have sufficed, and the dimensions of the engines could have been reduced. If the ship had been built in the present day, no one would have dreamed of putting paddle engines into her at all, and 6,000 indicated horse power could have been easily transmitted through the existing shaft.

Having thus rapidly sketched the construction of the ship, we may now glance at her eventful history. The construction of the ship originated in the fertile brain of Brunel, who was never so happy as when producing something bigger than any other engineer had contemplated. The Great Eastern was built for the Eastern Steam Navigation Company, a company incorporated by royal charter, and was intended for the Indian and Australian route by the Cape of Good Hope. The capital of the company was £1,200,000, in shares of £20 each, with power to increase to £2,000,000, of which about £600,000 was called up and expended in the construction of this vessel. A further sum of £172,000 was required for internal fittings and other matters before she was fit for sea.

The construction of the Great Eastern having been determined on by the Eastern Steam Navigation Company, on the 1st of May, 1854, the building of the great ship was commenced, on the lines laid down by Mr. Scott Russell, on the Thames. She was intended to be the first of four. She was launched broadside on, and being checked on the ways she stuck, and the result was the failure of the company. A new company was formed, which launched her at a cost of about £30,000 for the launching alone. The ship was first known as the Leviathan. The new company called her the Great Eastern, and she remained in its hands until 1864, when the Great Eastern Steamship Company bought her for the insignificant sum of about £80,000. Messrs. Glass and Elliott, electricians, chartered her to lay the Atlantic cable, and Messrs. Glass and Elliott became the Telegraph Construction and Maintenance Company in 1865. She went out cable laying under the charter in 1866, at the end of which year she returned to Liverpool, where she lay for a while. In 1867 she was chartered by a French company to convey passengers from New York to Brest for the French International Exhibition. She made only one voyage when the company failed. She was taken up again in October, 1868, by the Telegraph Construction and Maintenance Company, and laid the French cable from Brest to St. Pierre.

On her return in 1869 she loaded up the Indian cable and sailed for Bombay in November of that year, going round the Cape, and coaling there and at St. Vincent, passing through the Mozambique Channel. She laid the cable from Bombay to Aden and up to Jeb el Tir. She returned round the Cape to Sheerness. The charter was continued for five years, and while at Sheerness she had one set of boilers taken out of her, another set renewed, and the rest were thoroughly repaired in 1871. The next year she laid a new Atlantic cable, and raised and repaired the old one. In 1875 she was taken to Milford, and has remained there ever since. She went into the dock works, and these docks were really constructed round her, the ship being moved from time to time, until the dock so nearly approached completion that she had to be taken out into the haven. In 1878 she was put on a gridiron, cleaned, and repaired. No less than 300 tons of mussels were taken off her bottom, and weeds 10 ft. long, with stalks as thick as a man's wrist. In 1880 a company was devised to import fresh meat, and she was chartered by the company, which, however, could not be floated. Negotiations were then entered into with Mr. De Mattos for her purchase, which fell through. In 1884 a syndicate was formed to charter her for the New Orleans Exhibition. She was to lie off the city in the river, and be used as a magnificent floating hotel, and no doubt the idea which Messrs. Lewis have now carried out originated with the syndicate. The syndicate failed, however, to carry arrangements through. Litigation commenced, and at last the ship was sold by public action, and purchased by Mr. De Mattos for £26,000.

During her whole life large sums of money have been regularly spent on her in keeping her in repair. She has made in all eight or ten trips with passengers across the Atlantic. She has carried troops to Quebec. In 1863 she knocked a hole 83 ft. long in her bottom, on Montauk Point. In 1860 she encountered the storm in which she lost her paddles and broke her rudder head. A sensational story was told at the time about the fitting of jury steering gear by an American engineer, Mr. Towle, which, like many other sensational stories, is not true.

She was first commanded by Captain Harrison, and successively by Captains Kennedy, Thompson, Walker, Pattin, Anderson—now Sir James Anderson—and Halpin. Her first chief engineer was Mr. McLennan. He was succeeded by Mr. Vine Hall, and he in turn by Mr. Rorison, whose place was finally taken by Mr. George Beckwith, who was in her from the first, and gradually rose to be chief. Mr. Beckwith remained in charge of her in Milford, and carried out all repairs, such as putting in two new masts. Mr. Beckwith finally went into partnership with Mr. Bainbridge, establishing the Strand and North Dock Engineering Works, Swansea. Mr. Bainbridge has, however, retired, and Mr. Beckwith now practices as consulting engineer, while at his works every description of marine engineering is carried on.—*The Engineer.*

SIGNAL WIRE RUN THROUGH A PIPE FILLED WITH OIL.

By WILLIAM H. DECHANT.

DURING last September, a distant signal was required to protect a new crossing over the Little Schuylkill Branch of the Philadelphia and Reading Railroad, between East Mahanoy Junction and Tamanend. The distance from the operating office to the semaphore signal post is 1,100 feet, and is part way along a 4 and a 6 degree curve.

Instead of leading the wire through a long wooden box, supported on small pulleys, as is usually done, above the surface of the ground, it was decided to try the experiment of running the wire through a pipe filled with oil, buried below the surface of the ground. A trench, averaging fifteen inches in depth, was dug along a carefully laid out line; stakes eight feet apart were driven along the bottom of this trench, so that their tops should come to a uniform grade line, which, in this case, was about 66 feet per mile; upon the tops of these stakes the ¾ inch galvanized iron pipe was fastened, so as to hold it in as true a position as possible.

A number 15 iron wire was strung through each piece of pipe as they were screwed together, so that it might be used to draw the signal wire through the pipe line after it was all laid. The pipes were all carefully examined and cleaned; a number had to be rejected on account of lumps of iron or galvanizing material obstructing the bore of the pipe. After the pipe was all laid, the $\frac{3}{16}$ inch iron signal wire was stretched out with block and tackle to straighten it and take out all the short kinks, and it was then pulled through into its proper position in the pipe by the smaller wire that had been strung through during the laying of the pipe. A small brass stuffing-box was screwed to each end of the pipe, through which the ends of the leading wire were passed. These stuffing-boxes prevent the escape of the oil. The ends of the pipe being thus closed up, it was filled with common car lubricating oil, mixed with about one-quarter part of refined coal oil, to keep it from thickening in cold weather. The filling was done through a short upright branch pipe, attached at the highest end of the pipe.

The lever by which the distant signal is operated at the signal office, by the same movement turns four signal boards on the tower; and during the summer the usual counterbalance on the semaphore signal post, adjusted to exert its least weight, would operate the arm on the signal post and revolve the signal boards on the tower; during the colder weather the lubrication is possibly slightly stiffened, so that this same counterbalance barely turns the signal boards in the tower, and must have slight assistance.

The experiment has proved very successful thus far in the severe weather of this winter, and the apparatus has required no attention since being placed in position.

The apparent advantages of this plan are:

1. A very permanent and lasting arrangement.
2. Freedom from disturbance or accident to the signal wire.
3. Entire freedom from the difficulties caused by expansion, if the pipe is laid below the frost line; and subjection to but slight changes caused by change of temperature, if laid only one foot under ground.
4. Obviating the necessity to provide angle fixture to change the direction of the wire around curves.

The difference in cost of materials per 100 feet is but a trifle, being \$5.38 for the pipe plan and \$5.42 for the wooden box plan. The difference in labor would depend upon the character of the ground, but in most cases it would be nearly the same.—*Proc. Engineers' Club.*

GAS AND CARBURETED AIR MOTORS.

MR. LENOIR, in a patent taken out in 1860, was the first to offer a truly practical method of obtaining power through illuminating gas. Since then, continual progress has been made, and Mr. Lenoir himself has succeeded in modifying his first motor in such a way that it is now capable of operating either by gas or carbureted air, by a slight change.

The Gas Motor.—This apparatus, like many others, is a compression engine, but it is characterized by the addition of a new part—a heater, which is placed back of the cylinder, and serves at the same time as a compression chamber.

In all other styles of gas motors, it is the cylinder that contains the compression chamber; and the result is that, as the cylinder needs to be cooled, the compression chamber, also, is necessarily cooled. Owing to this fact, there is a great loss of heat. Mr. Lenoir avoids this by making his compression chamber an apparatus perfectly distinct from the cylinder. This arrangement, by preserving the heat, permits of obtaining a large saving in the output of gas—the quantity used being but twenty-five cubic feet per horse and per hour.

The gas is lighted by electricity. The spark from a Ruhmkorff coil fires a detonating mixture in the immediate vicinity of the throttle valve, and at a point where the lubricating oils do not enter. This arrangement dispenses with a slide valve—the most delicate part of most motors—and effects a great saving in lubricators. As well known, in fact, a slide valve, to operate normally, must be constantly covered with oil; and yet, despite this continuous lubrication, it is very difficult to prevent frequent griping.

In the arrangement adopted by Mr. Lenoir, which is applicable to motors of from two to eight horse power, such a trouble does not occur.

Carbureted Air Motor.—In these motors, air carbureted by means of gasoline or naphtha, at a density of 0·65, is substituted for illuminating gas. For using naphtha, Mr. Lenoir has provided his motor with a supplementary device—a carbureter. This consists of a cylindrical vessel, divided into a certain number of compartments, and which, through the motor itself, is given a slow rotary motion that brings about a perfect carbureting of the air. It is filled about a third full of the hydrocarburet, and when thus charged is capable of operating for ten hours with an output of about fourteen fluid ounces of gasoline per horse and per hour. The air, which is sucked in by the piston, is, on making its exit from the carbureter, introduced into the cylinder and compressed in the heater, where it takes fire, and produces a dynamic effect similar to that of illuminating gas. The mixture is inflamed, as in the gas motor, by an electric spark. This motor possesses the advantage of being capable of furnishing power in any locality where illuminating gas does not exist, such as on farms and so forth, and in any place where, although the gas works be at a distance, it is at least easy to lay in a store of naphtha.—*Le Genie Civil.*

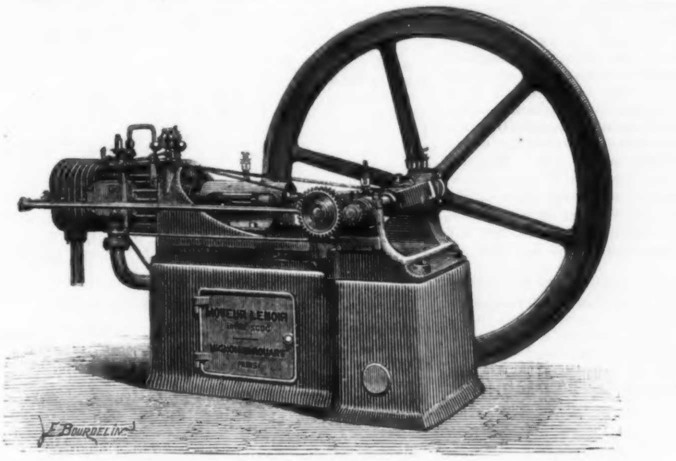


FIG. 1.—LENOIR'S GAS MOTOR.

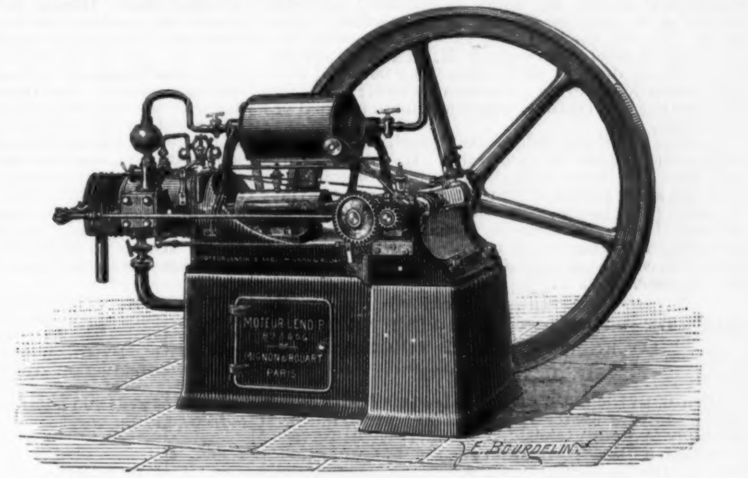


FIG. 2.—LENOIR'S CARBURETED AIR MOTOR.

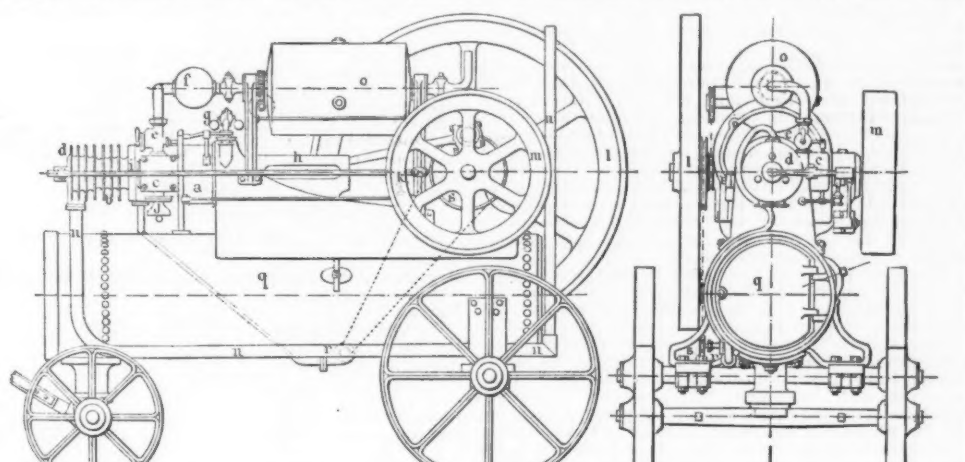


FIG. 3.—THE MOVABLE CARBURETED AIR MOTOR.

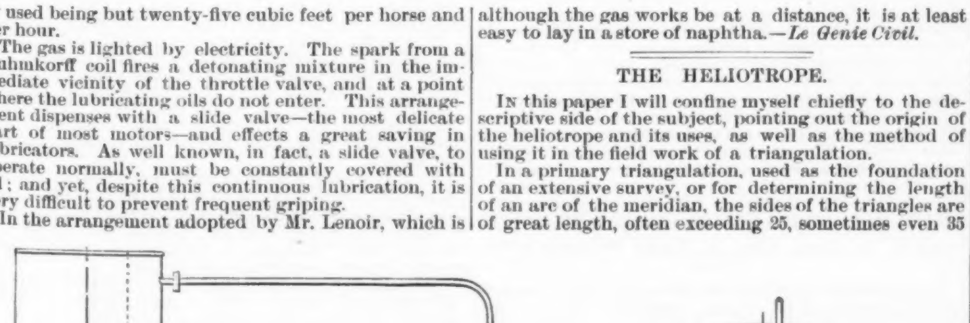


FIG. 4.—THE CARBURETED AIR MOTOR.

THE HELIOTROPE.

IN this paper I will confine myself chiefly to the descriptive side of the subject, pointing out the origin of the heliotrope and its uses, as well as the method of using it in the field work of a triangulation.

In a primary triangulation, used as the foundation of an extensive survey, or for determining the length of an arc of the meridian, the sides of the triangles are of great length, often exceeding 25, sometimes even 35 miles, and in mountainous regions where the air is very clear, sides of a much greater length are used. As an instance of this kind we may name the great Davidson quadrilateral in the California triangulation. The sides of the triangles making up this quadrilateral are the longest ever measured anywhere, and vary from 54 to 194 miles in length.

On lines not longer than 15 miles, the observations are usually made on what are termed signals. A signal as now used in the Pennsylvania triangulation consists of a straight pole of wood from 3 to 4 inches in diameter and from 10 to 15 feet in length, on one side of which is fastened a framework or any flat surface about 18 inches wide, upon which two pieces of muslin, the one black and the other white, are tacked. This signal is set exactly over the center of the station, and faces the observer. It is necessary that the signal should be accurately centered and truly vertical. A deviation of 0·307 inch will make an error of one second in a line one mile long or 0·1 second in a line ten miles long.

That such a signal would be useless, however, on long lines, except under very favorable conditions of the atmosphere, must be apparent.

As long as the air is clear and free from mists, signals will do very well to observe upon; but let even a light haze obscure the view of the distant mountains, and signals become useless even at short range. It was this that in earlier times retarded the field work of a triangulation, forced the observer to use shorter lines, and thus increased the work.

When Schumacher and Gauss commenced their triangulation in Germany, in the early part of this century, the heliotrope was unknown, and signals only were used. The weather was unusually hazy when they were in the field, and the want of something that could be used to observe upon in such weather undoubtedly hastened the invention of the heliotrope.

In a letter to Schumacher, dated July 11, 1821, Gauss says: "I will gladly contribute to your new journal, if circumstances allow. Perhaps a report on my new instrument, which I intend to call a heliotrope, might make the first paper. I hope that this manner of making observations may be made of the greatest importance for the higher geodesy. For short distances (up to two miles) you can imagine no better point to sight upon than the reflected light from a bright cloud; reflected sunlight will, I hope, make a most excellent point at the very greatest distances."

At what distances it actually is used at the present day would probably surpass Gauss' wildest expectations.

Gauss' heliotrope was, however, a clumsy and complicated instrument when compared with those now used. The form of heliotrope in use in this country is quite simple, consisting essentially of a board or telescope, upon which are mounted, in the same vertical plane as the axis, two rings, and behind these a mirror about 2 inches in diameter, having a motion about a vertical and a horizontal axis.

The size of the mirror depends on the distance to flash over. Prof. Davidson, of the U. S. Coast and Geodetic Survey, found that a mirror of 7¾ square inches area sufficed for his longest line, 192 miles. At that distance he saw, with a small telescope, a heliotrope light from a mirror 12 inches square.

It is only necessary to set the instrument, by the rings on the telescope; upon the point at which it is desired to flash, and the reflected sunlight traveling parallel to the line of sight must strike the point.

To find the point upon which the heliotrope is to flash, the healiotroper proceeds as follows: From his station he finds with his pocket compass, as nearly as possible, the direction of the observer's station. This direction has been determined roughly from the best available maps and a reconnaissance. After carefully centering his heliotrope over the station (the same care being necessary for centering here as in a signal), he points it at the place where he supposes the observer's station to be. He allows his light to flash several degrees on either side of where he is pointing, and keeps a sharp lookout for an answering flash from the observer, who is likewise flashing at the heliotroper. Sooner or later one sees the other's light, and immediately points his heliotrope exactly.

It is now an easy matter for the heliotroper to get a good pointing, and to keep it, provided his instrument is in good adjustment; if it is not, his troubles have just commenced, for he may then have to point his instrument in a dozen different directions before he finds one which satisfies the observer. When he has secured such a pointing, the observer signals him by means of flashes that his light is good. After this the heliotroper has only to keep his mirror turned so that the reflected sunlight may travel in the proper direction—an intensely interesting and, above all, a highly intellectual occupation.

It is hardly necessary to point out the advantages of the heliotrope over signals. The long lines above men

tioned would of course never have been measured without it. To be sure, it can be used in cloudy weather at all hours of the day. Toward noon and for several hours following the light is very large, pale, and blurred, and it has besides this a very strong vibratory motion. At times indeed the disturbing influences of the air are so great that no trace of the light can be found, even when its direction is accurately known. As the afternoon advances the light becomes smaller and more steady, and during the hours immediately preceding sunset it is seen as a small, often perfectly quiet, point. Indeed, the very best time for observing on a heliotrope is from six to seven P. M. on a clear, still evening. Work done at such times may be relied upon, while work done during noon hours is never so reliable, whether the observations were made upon a signal or a heliotrope.

Another use of the heliotrope, though rather a secondary one, is that of a telegraph. It will be readily seen how the Morse alphabet can be represented by long and short flashes of light, and how a message may be sent by this means. The principal objection to this method of correspondence is perhaps the difficulty of attracting the attention of the person with whom it is desired to communicate.—*John S. Siebert, Engineering Society Journal, L. U.*

THE CONSTRUCTION AND TESTING OF AIR LOCKS AND SHAFT TUBES.*

By L. Brennecke.

Although the question of the best method of design and of testing steam boilers is one which has been generally carefully considered, and receives universal attention, a like investigation of a kindred subject, viz., that of the apparatus used for sinking foundations under a high air-pressure, has nowhere hitherto been carried out, although the consequences of an accident are likely to be even more disastrous in the latter instance than in the former, as in this case the men are actually inclosed in the apparatus, and so situated that they must in the event of an explosion be subject to its full effects. Also the strains which an air lock sustains are of a very unfavorable character, owing to the vibration caused by the work proceeding in its interior, and the constant changes of temperature and of pressure to which it must be subjected when in use. The bursting of an air lock is instanced, where the fractured portions on examination showed a highly crystalline structure, although the iron used in its manufacture had been of the best quality. Up to the present time, the number of accidents known to have occurred in consequence of the bursting of air locks is three, viz.: first, 1865, at Zeche Rheinpreussen, where two men were killed in the lock; second, in 1873, on the Tay Bridge works, where six men who were below in the excavating chamber lost their lives; third, in 1877, on the Alexander Bridge works, St. Petersburg,† when ten men were blown into the air and killed, and nineteen men below in the excavating chamber were drowned, their bodies not being recovered till twelve months later. These three accidents, spread over a period of twelve years, were the cause of a loss of thirty-seven lives, which, compared with the statistics of the results of boiler explosions, show that air-lock accidents are much more disastrous; these considerations lead to the conclusion that this apparatus should receive as much attention in the way of periodical examination and testing as is applied to steam boilers, an easy matter, as those now engaged constantly in testing steam boilers hydraulically could equally well carry out the testing of air locks in a similar manner. There should also be rules formulated for enabling the strains upon the air lock shafting, etc., to be easily found. The author intends publishing a series of calculations in reference to the strains upon the various parts of the whole apparatus in an early edition of the *Deutschen Bauhandbuch;* and he in this paper enters minutely, by a series of equations, into the question of the strains around the opening made in the wall of the cylindrical air lock for the door, based upon the principle that a cylinder with closed ends, under pressure from within, is mainly subjected to two strains, the one $P \times R$ acting circumferentially and tending to split the cylinder wall vertically, and the second $\frac{P \times R}{2}$, or half the intensity of the first, acting at right angles to it—or in a direction parallel to the axis of the cylinder—where P=pressure on area of wall and R= radius, from which is deduced that if the frame around the rectangular doorway be of insufficient strength, rupture will commence at the angles; and he advises that in all cases with either rectangular or circular doorways, in addition to the framing at the side of the door a ring of flat bar iron of a diameter equal to the diagonal of the rectangular door, and with a sectional area of $\frac{3}{4}\,\frac{p \times R \times a}{k}$ (where a=height of door opening and k= unit strain), shall be riveted to the wall of the cylinder. This will take the main strains above alluded to. The pressure in addition to the above, acting upon the back of the door from within outward, may be met by riveting an angle iron ring on to the before mentioned bar iron ring.

The author suggests that adoption of certain rules—of which the following is an abstract—with regard to the working of air locks and shafts might be of service, viz., the iron to be of the best quality, with a tensile resistance of 22·86 tons per square inch, and 21·6 tons per square inch with and across the fiber respectively; cast iron may only be used for the tubes, which, if subjected to pressure from within, do not exceed 12 in.—30 cm.—in diameter, and if from without 24 in.—60 cm.—in diameter, and may not be used for those parts subjected to vibration; pipes of brass or copper may not exceed 4 in. in diameter; the coefficient of safety to be at least five times the strain; shaft tubing, in calculation, to be assumed as subject to occasional pressure from without. A manometer to be provided in each air lock, also a plate affixed to the latter, giving the name of the manufacturer, the working pressure for which it is calculated, and the date of the trial test.

At every new installation and also at intervals of not more than twelve months, while in use on the same works, the whole apparatus to be tested under a hydraulic pressure of twice the intended working pressure. In testing, the full pressure shall be continued for at least ten minutes without producing signs of weakness, by the buckling of plates or escape of water other than in the form of dew. The result of this test to be entered in a register. An air lock is, at the extreme, not to be in use for more than one thousand five hundred days, and in this amount the intervals between work are to be reckoned as one-fifth of the working time. During the second half of the above period the air locks are to be used only in conjunction with the excavating chamber, in which the pressure does not exceed two-thirds of that for which the air lock was originally intended. As before remarked, after a period of one thousand five hundred working days, a lock should not under any circumstances be continued in use for high pressure foundation works, and a register should be kept by some responsible person upon the works of the number of working hours, and the degree of pressure from day to day. Regarding the shaft tubing, this may be considered serviceable for a period of five thousand working days, and a full allowance made for the hours when not in work, as the strains to which it is subjected are of a less unfavorable character than those sustained by the air lock.

In conclusion, the author especially urges the necessity of a careful register of the working of the apparatus, in regard to the particulars above mentioned being imperative. By this means, in the case of the apparatus at the completion of works being disposed of, those taking it over may be fully acquainted with the amount of wear and tear to which it has been subjected.—*D. G., the Engineer.*

* Abstract Proc. Inst. C. E., vol. lxxxiii., from *Zeitschrift fur Bauwesen. The Engineer.*

† Minutes of Proceedings Inst. C. E., vol. lxxv., p. 286.

DEPOSITS OF DIATOMITE.

Deposits of diatomite, remarkable both as to quality and quantity, have been lately found in the north of Skye. The localities in which the material is found in abundance are Loch Quire and Loch Columbkile, while small quantities have been found in Glensnisdale and at Sartil, also in still smaller quantities in two or three other places.

The finest and largest of these deposits is in Loch Quire, and its analysis shows, after calcination, about 96½ parts of diatomaceous frustrules to the 100, while 100 parts of the material absorb about 269 of water. This deposit is described as unequaled for the manufacture of silicate and ultramarine paints, and various other purposes; it may also be used for the manufacture of dynamite, and is peculiarly adapted for the making of siliceous glaze for pottery wares, or for the manufacture of boiler and steam-pipe coatings.

The material might also be available in the manufacture of glass, porcelain, papier-maché, isolating felt, caoutchouc, and other materials. It would be useful as an absorbent of fluids, and the surface layers, which are not quite so pure, but are equally absorbent, could be applied in combination with precipitated town sewage for manurial purposes. Among other purposes to which diatomite may be applied is the polishing of glass and metals, the cleaning of cloths, and it is understood it can also be used for the refining of sugar. It is thought that on the main body of the deposit being cut into, the material will improve in quality, as shown by the borings, for the sample analyzed was one from the surface, which is affected by the presence of aquatic weeds.

The great purity of the Quire deposit is evidently due to the quality of the spring water with which the loch is fed, and this is further evidenced by the diatoms in it appearing in less variety than in other deposits where the feeding streams are of a more varied description. The deposit in Loch Quire, so far as bored, and not including some eight acres of rather rough ground, shows what would be about 72,000 tons of diatomite when dried, but as, excepting a very few points, no bottom was found to fully 14 ft. of diatomite, there seems no doubt that the deposit will prove very much greater, probably 100,000 tons, or even very much more, for from the general appearance and steepness of the basaltic rocks around this basin, conjecture points to it as a volcanic blow-hole or neck of great depth; while every additional depth of 3 ft. of diatomite over its space would yield about 15,000 tons of dried material.

It may be mentioned that the loch is filled to the surface with diatomite having 3 ft. or 4 ft. of rooty matter above, and over which one can for the most part walk, except where the stream meanders through. The loch could easily be drained by lowering the outlet. The deposit in the drained flat of Loch Columbkile seems to extend to about forty acres of considerable depth. The deposits in Glensnisdale, Duntulm, and Sartil are of more limited extent.

NATURAL GAS VERSUS COKE AND COAL.

By S. A. Ford, Chemist Edgar Thomson Steel Works.

So much has been claimed for natural gas as regards the superiority of its heating properties as compared with coal that some analyses of this gas, together with calculations showing the comparison between its heating power and that of coal, may be of interest to your readers.

These calculations are, of course, theoretical in both cases, and it must not be imagined that the total amount of heat in a ton of coal or in 1,000 cubic feet of natural gas can ever be fully utilized.

In making these calculations, I employed as a basis what in my estimation was a gas of an average chemical composition, as I have found that gas from the same well varies continually in its composition. Thus, samples of gas from the same well, but taken on different days, vary in nitrogen from 23 per cent. to nil, carbonic acid from 2 per cent. to nil, oxygen from 4 per cent. to 0·4 per cent., and so with all the component gases.

Before giving the theoretical heating power of 1,000 cubic feet of this gas, I will note a few analyses. The first four are of gas from the same well, samples taken on the same day that they were analyzed. The last two are from two different wells in the East Liberty district.

I also give a few analyses of Siemens producer gas. The immense heating power of the natural gas over the Siemens may be seen at a glance when compared bulk for bulk.

NATURAL GAS.

	1.	2.	3.	4.	5.	6.
When Tested.	Oct. 28, 1884.	Oct. 29, 1884.	Oct. 24, 1884.	Dec. 4, 1884.	Oct. 18, 1884.	Oct. 25, 1884.
	Pr. ct.	Pr. ct	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.
Carbonic acid.....	0·8	0·6	nil.	0·4	nil.	0·3
Carbonic oxide....	1·0	0·8	0·58	0·4	0·1	0·6
Oxygen....	1·1	0·8	0·78	0·8	2·10	1·20
Olefiant gas.....	0·7	0·8	0·98	0·6	0·8	0·6
Ethylic hydride..	3·6	5·5	7·92	12·3	5·2	4·8
Marsh gas.	72·18	65·25	60·70	49·58	57·85	75·16
Hydrogen.	20·62	26·16	29·03	35·92	9·64	14·45
Nitrogen..	nil.	nil.	nil.	nil.	23·41	2·89
Heat units	728,746	698,853	627,170	745,813	592,380	745,591

SIEMENS PRODUCER GAS.*

Carbonic acid.....	3·9	8·7	9·3	1·5	6·1
Carbonic oxide....	27·3	20·0	16·5	23·6	22·3
Hydrogen.........	....	8·7	8·6	6·0	28·7
Marsh gas........	1·4	1·2	2·7	3·0	1·0
Nitrogen..........	67·4	61·4	62·9	65·9	41·9
Heat units........	93,966	97,184	99,074	114,939	164,164

We will now see how the natural gas compares with coal, weight for weight, or, in other words, how many cubic feet of gas will contain as many heat units as a given weight of coal—say a ton.

In order to accomplish this end, we will be obliged, as I have before said, to assume as a basis for our calculations what I consider a gas of an average chemical composition, viz.:

	Per cent.
Carbonic acid........................	0·6
Carbonic oxide........................	0·6
Oxygen........................	0·8
Olefiant gas........................	1·00
Ethylic hydride........................	5·00
Marsh gas........................	67·00
Hydrogen........................	22·00
Nitrogen........................	3·00

Now, by the specific gravity of these gases we find that 100 liters of this gas will weigh 64·8585 grammes, thus:

Marsh gas.........	67·0 L.	weighs	48·0256	grammes.
Olefiant gas.......	1·0	"	1·2534	"
Ethylic hydride...	5·0	"	6·7200	"
Hydrogen.........	22·0	"	1·9712	"
Nitrogen.........	3·0	"	3·7652	"
Carbonic acid.....	0·6	"	1·2257	"
Carbonic oxide....	0·6	"	0·7526	"
Oxygen...........	0·8	"	1·1468	"
Total........................			64·8585	

Then, if we take the heat units of these gases, we find that—

Marsh gas.....	48·0256 grms.	contain	627,358	heat units.
Olefiant gas...	1·2534 "	"	14,910	"
Ethylic hydride.	6·7200 "	"	77,679	"
Hydrogen....	1·9712 "	"	67,939	"
Nitrogen......	3·7630 "	"	......	"
Carbonic oxide.	0·7526 "	"	1,808	"
Carbonic acid.	1·2257 "	"	......	"
Oxygen.......	1·1468 "	"	......	"
Total......	64·8585		789,694	"

64·8585 grms. is almost exactly 1,000 grains and one cubic foot of this gas will weigh 267·9 grains; then the 100 liters, or 64·8585 grms., or 1,000 grains, is 3·761 cubic feet.

3·761 cubic feet of this gas contains 789,694 heat units, and 1,000 cubic feet will contain 210,069,604 heat units.

Now, 1,000 cubic feet of this gas will weigh 265,887 grains, or, in round numbers, 38 lb. av.

We find that 64·8585 grms., or 1,000 grains, of carbon contain 52·4046 heat units, and 265,887 grains, or 38 lb., of carbon contain 139,398,896 heat units. Then, 57·25 lb. of carbon will contain the same number of heat units as the 1,000 cubic feet of the natural gas, viz., 210,069,604.

Now, if we say that coke contains in round numbers 90 per cent. carbon, then we will have 62·97 lb. of coke, equal in heat units to 1,000 cubic feet of natural gas.

Then, if a ton of coke, or 2,000 lb., cost $2.50, 62·97 lb. will cost 7·8 cents, or 1,000 cubic feet of gas is worth 7·8 cents for its heating power.

We will now compare the heating power of this gas with coal, taking as a basis a coal slightly above the general average of the Pitsburg coal, viz.:

Carbon........................	82·75
Hydrogen........................	5·31
Nitrogen........................	1·04
Sulphur........................	0·95
Oxygen........................	4·64
Ash........................	5·31

We find that 38 lb. of this coal contain 146,903,820 heat units; then, 54·4 lb. of this coal contain 210,069,604 heat units, or 54·4 lb. of this coal is equal in its heating power to 1,000 cubic feet of the natural gas.

If our coal costs us $1.20 per ton of 2,000 lb., then the 54·4 lb. costs 3¼ cents, and 1,000 cubic feet of gas is worth for its heat units 3¼ cents.

As the price of coal increases or decreases, the value of the gas will naturally vary in like proportions.

Thus, with the price of coal at $2.50 per ton, this gas will be worth 6·8 cents per 1,000 cubic feet.

If 54·4 lb. of coal is equal to 1,000 cubic feet of gas, then 1 ton of coal is equal to 36,764 cubic feet.

In these calculations of the heating power of gas and coal no account is, of course, taken of the loss of heat

* See vol. xi., p. 300, Transactions of American Institute of Mining Engineers.

by radiation, etc. My object has been to compare these two fuels merely as regards their actual value in heat units.

In collecting samples of this gas, I have noted some very interesting deposits from the wells. Thus, in one well the pipe was nearly filled up with a soft, grayish-white material, which proved, on testing, to be chloride of calcium. In another well, soon after the gas vein had been struck, crytals of carbonate of ammonia were thrown out, and upon testing the gas I found a considerable amount of that alkali, and with this well no chloride of calcium was observed until about two months after the gas had been struck.—*American Manufacturer.*

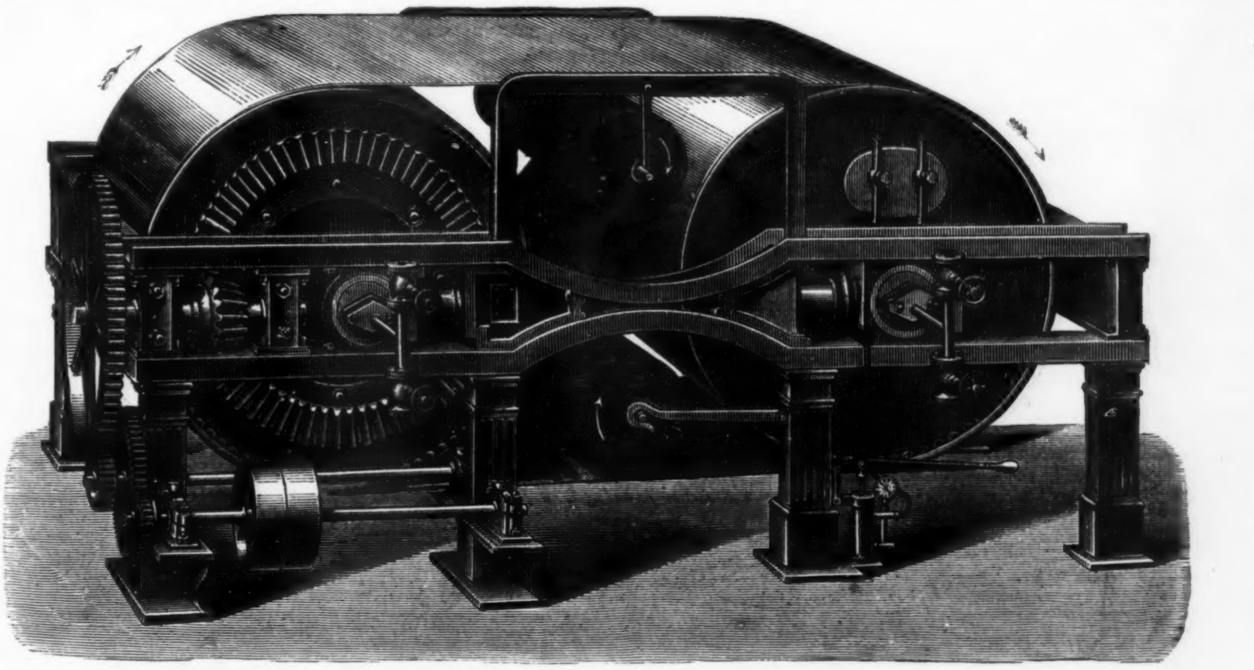
PRESS FOR FINISHING FABRICS.

THE best finish for fabrics is obtained by putting them into a press with sheets of cardboard and steam-heated plates of metal, and afterward allowing them to cool under pressure. This process requires much time and manual labor; and, moreover, the cost of the cardboard is considerable, and it is necessary to perform the operation twice, in order to remove the creases made by the extremities of the first cards.

Messrs. Rudolph & Kuhne have devised a style of rotary press with endless apron, by means of which some of these disadvantages are overcome. It consists (see figure) of two iron cylinders five feet in diameter, which have a polished surface and are supported by a strong frame. An endless metallic apron passes around them and covers half of their surface. One of the cylinders is heated by steam, and the other is kept cold by a current of water. Pressure upon the fabric is obtained by causing the cylinders to recede from each other by means of two hydraulic pistons, fed by a small hand pump affixed to the machine. The pressure is shown by a gauge.

After the stuff to be pressed has been wound upon a roller, the latter is placed in the upper part of the frame and the end of the piece of goods is passed under and over the heated cylinder. After making a half revolution of the latter, the fabric follows the apron and reaches the cold cylinder, and, after making a half-revolution of this, it winds around a metallic roller. The operation is then finished.

This machine does away with some of the inconveniences connected with the vat press, over which it is possible to pass only fabrics of a regular thickness and without selvage. It introduces a new element into the finishing of fabrics, and everything leads us to believe that its introduction into finishing works will mark a genuine progress.—*Revue Industrielle.*



PRESS FOR FINISHING FABRICS.

STEARINE IN FINISHING COTTON TISSUES.

By GEORG HERTEL.

IT is a known fact that thus far stearine has not been made available for finishing purposes, at least not without considerable difficulties, because, being a solid fat of little specific weight, it floats upon the surface of any aqueous liquid, is insoluble in water, and can, therefore, only with difficulty be distributed in water, and in many cases not at all. Its employment for finishing has been repeatedly attempted on account of its pure white, transparent mass of a full but, at the same time, delicate feel; but, to my knowledge, a desirable result has never yet been obtained with it, on account of its above mentioned properties. I was recently, however, called upon to solve a problem which left me no alternative but to take up the question of stearine and to further experiment with that substance. I mixed 10 kil. stearine with 5 lit. alcohol 95 per cent. and the same quantity of water, which mixture was ground together in a tightly closed mill for 24 hours; when the white paste thus obtained was distributed in thin layers upon several pans and left therein, under frequent agitation, for 3 days. The surplus alcohol being removed in this manner by evaporation, the whole hygroscopic mass, attracting still more water from the air, remained in the form as a thick paste containing water. I then boiled 25 kil. gum arabic with 100 lit. water, and, when cold, I stirred this solution together with the stearine preparation. This mixture I allowed to stand for 3 more days, when I passed the whole sizing mass through a fine sieve, added 150 lit. water, heated to 145° F., and finally applied it with complete success. In this process the stearine, of course, remains also undissolved, but it is well and finely distributed in the water, allowing of its application for finishing purposes, because the minute granules of stearine do not longer float, but remain in a condition of emulsion enveloped in gum and are first liberated upon the heated finishing cylinders, where they melt by the heat spreading a fine film of stearine over the entire surface of the tissue.

The thinnest cotton fabrics finished in this manner obtain a peculiarly firm touch, although not the least trace of a strong size is noticeable, because the stearine insensibly penetrates the tissue, whether white or colored, and moderates the unpleasantly harsh gloss of the gum. The tissue is given a pleasing luster, and has no soapy odor.

In further use, and even if preserved for some time, the stearine thus treated does not separate and again rise to the top, but remains in a constantly improving union with the water. It is easy to comprehend, however, that the mass must in no instance be heated above 145° F.; but in this condition any other sizing material can be added to it.—*Faerb. Must. Ztg.; Tex. Colorist.*

BLEACHING AGENTS.

No one salt of chlorine seems to be capable of supplying the multiplied wants of the bleacher of vegetable fiber. Chlorinated lime (chloride of lime) has long been the most available and the most generally employed for the purpose; but the probability exists that the corresponding salts of magnesia, of alumina, and of zinc possess specific qualities which indicate their employment in certain cases. As to what these qualities are, and in what cases one of the salts may be the best, dyers and printers are not agreed. Nor will this be a matter of surprise if we reflect how little the properties of these salts have been studied. For the most of what we know on the subject we are indebted to Lunge and Landalt, who, having exposed the fallacy of the claims set up for chlorozone, pushed their investigations further, and determined the comparative value of other bleaching agents.

HYPOCHLORITE OF MAGNESIA.

This salt is usually made for industrial purposes by adding chlorinated lime to Epsom salts, both being in solution. Balard obtained it pure by dissolving magnesia in an aqueous solution of hypochlorous acid, and Grauvelle procured it mixed with other salts by passing a current of chlorine into milk of magnesia. One of these salts is the chlorite, which is much more largely produced than the corresponding salt of lime would be under similar circumstances. The hypochlorite of magnesia is quite stable. A solution of chlorinated lime mixed with one of sulphate of magnesia, in such proportions that all the lime is thrown down in the form of sulphate, gives a liquid almost as rich in bleaching power as the original lime solution, and quite as easily preserved unchanged.

HYPOCHLORITE OF ZINC.

When moist oxide of zinc is submitted to the action of chlorine, its behavior is very similar to that of magnesia. If a concentrated solution of chlorinated lime be mixed with a quantity of sulphate of zinc a little greater than that necessary for double decomposition, a liquid is obtained which can often be utilized in the bleacher's industry. After this reaction the percentage of chlorine in the state of chloric acid, as well as in that of hydrochloric acid, was found to be greater in the zinc solution than it was in the calcic, while that of decolorizing compounds of chlorine was reduced in the proportion of 1·97 to 1·66; 49 per cent. of this 1·66 was free hypochlorous acid. The loss of active chlorine may be ascribed to the instability of the hypochlorite of zinc and to the formation of oxychloride of zinc, which goes down with the sulphate of lime.

HYPOCHLORITE OF ALUMINA.

This compound cannot be produced either by subjecting hydrate of alumina to the action of chlorine or by passing a current of the gas through water containing hydrate of alumina in suspension. To form it, we must mix equivalent solutions of chlorinated lime and sulphate of alumina. Neither the quantity of chlorate nor that of hydrochloric acid will be sensibly augmented, while the diminution of the active chlorine will be less than in the case of zinc, the proportion being 1·97 : 1·88, instead of 1·97 : 1·66. The dissociation of the hypochlorite of alumina not taking place so rapidly as that of zinc, the solutions of the former may be longer preserved.

BLEACHING EXPERIMENTS.

These were undertaken with the view of making known the relative energy of the different decolorizing solutions employed in industry. The conditions under which the experiments were performed were always identical. Small strips of cotton cloth cut from the same piece, which had previously been dyed Turkey red, were used. They were first moistened, then placed in the decolorizing liquids, and the times required to bleach them noted. The results are useful indications of the comparative value of the several liquids for the purposes of the bleacher. Before being used to bleach the Turkey red cotton, all the solutions were brought to the same chlorometric strength, as ascertained by careful titration, so the times in which the decolorizing took place, given in the following table, fairly represent the comparative energy of the salts employed:

	Hypochlorite of							
	Lime.		Magnesia.		Zinc.		Alumina.	
	h.	m.	h.	m.	h.	m.	h.	m.
Solution used without addition....	48	00	36	00	1	30	3	30
Solution used when current of carbonic acid had been passed through it for one minute......	6	00	6	30	0	33	2	10

While the magnesian solution acts almost as slowly as that of lime, that of alumina, and especially that of zinc, both of which contain free hypochlorous acid, prove themselves to be very active. Treating the solutions with a current of carbonic acid stimulates their bleaching action in all cases—an effect least marked in the solution of the salt of alumina, probably because that base is the only one of the four which does not combine with carbonic acid. When that acid was added in excess to chlorinated lime, the bleaching was found to be nearly as much hastened as if oxalic or acetic acid had been similarly used. How the proportion of the last-named acid stimulates the bleaching effect of the lime solution was thus shown: When 1 molecule of the acid was added for every 2Cl, decolorization took place in two hours and twenty minutes; when the proportion of acetic acid was doubled, but sixteen minutes were required.—*Textile Record.*

RELATIVE PERMEABILITY OF VARIOUS DIAPHRAGMS.

By A. ZOTT.

FROM the quantitative results attained on the dialysis of different crystalline and colloid substances, the following conclusions are arrived at: 1. The most useful, homogeneous, and watertight material as a dialyzer is goldbeater's skin, which is twice as effectual under the same conditions as parchment paper, hitherto considered on the authority of Graham to be the best substance. But in the case of solutions which attack organic membranes, ordinary clay cells are the most useful, although their permeability is sixty to seventy-five times less than that of goldbeater's skin.

2. The rapidity of the diffusion is increased by the complete exhaustion of the air collected within the pores of the dialyzer; the rapidity is also dependent rather on increase of volume of the solution than on increase of mass dissolved. After a preliminary exhaustion, endosmose takes places even in the case of slowly diffusible substances, such as the so-called colloids.

3. Two or more substances present in a solution are more rapidly and completely separated, the greater the difference of their diffusion velocity. The terms colloid and crystalloid are purely relative.

4. Separation by dialysis is more rapid, the more often the liquid in the outer vessel is renewed.

5. With decrease of concentration, the diffusion velocity of salts, whether dissolved separately or admixed, decreases up to a certain point, from which it again increases slowly.—*Journal of the Chemical Society.*

KENSINGTON COURT.

THE illustration which we give of Kensington Court shows the houses recently built, and in part occupied, at the southern end of the site, looking northward to Kensington Gardens. The design of the houses is varied in accordance with the necessities of their plans and varieties of taste. The walls throughout are of red brick, the architraves and cornices and other architectural features of brownish-yellow terra-cotta, except in the tall, gabled, Flemish-looking house, where they are of cut brick. The architect is Mr. J. J. Stevenson, and the drawing from which our illustration is taken is exhibited at the Royal Academy.—*Building News.*

CHLORINATION OF GOLD ORES.*

PLYMOUTH CONSOLIDATED GOLD MINING COMPANY, AMADOR COUNTY, CAL.

THE ore, as it is raised from the mine, has an average assay value of $11 a ton, chiefly in the form of free gold. All the ore goes directly to the stamp-mills, of which there are two. The older and larger mill contains sixteen batteries of five stamps each, with one Frue vanner to each battery. The new mill has eight batteries of five stamps and two Frues to each battery. The large mill is driven by Leffel turbine-wheels, with a pressure of eighty feet, and a consumption of 600 miners' inches of water. The smaller mill is driven by "hurdy-gurdy" wheels with a pressure of about 550 feet and a consumption of 150 inches of water.

At both mills, the tailings from the stamps pass over about 20 feet of plates on their way to the Frues. In each set of plates, the first or upper one is copper, the rest are so-called silver plates.

NEW BUILDINGS—KENSINGTON COURT.

The bullion from the stamps is about 800 fine in gold and 200 in silver.

The concentrates from the Frues average from 1¼ to 1½ per cent. of the ore stamped. They very rarely exceed two per cent. I was unable to get the exact assay value of the concentrates, but it is said to vary between $100 and $200 a ton.

The concentrates are treated at the chlorination works at the rate of one hundred tons a month. The capacity of the works is somewhat greater than this; but as the supply of concentrates is limited, it is not deemed advisable to work them up any faster.

Care is taken to keep the concentrates always damp until they are put into the roasting-furnace. If this is not done, a decomposition of the pyrites begins, forming lumps that do not roast, and which consequently cause a loss of gold in the residues from leaching.

A *Fortschaufelungsofen* is used for roasting. Its dimensions, including fire-box, are 12 feet by 80 feet. The hearth is one continuous plane, but the charges, of which there are three in the furnace at one time, are kept entirely separate. The furnace men call the three compartments the "drying," the "burning," and the "cooking" compartments. In the middle or "burning" compartment, the ore is spread out very thin, and occupies about double the space of either of the other compartments.

The furnace is worked by eight-hour shifts, one man on each shift, and one charge is drawn and a new one added in each shift. The charges weigh 2,400 pounds, and carry about 10 per cent. of moisture. The ore averages about 20 per cent. in sulphur, and just before the sulphur ceases flaming (in the second division of the furnace), 18 pounds, or ¾ per cent., of salt are added to the charge.

The roasted ore from each shift is kept by itself on the cooling-floor until a tankful (about 4 tons) has accumulated from a single man's shift; then that lot is worked by itself. This enables the person in charge the better to control the roasting; for if only one lot out of the three is bad, it is presumable that the fault lies with the workman; but if all three are bad, the probabilities are that there has been a material change in the character of the ore, and the roasting process must be altered accordingly.

The vats for chloridizing the roasted ore are 9 feet in diameter by 3 feet in height, and are four in number. They are slightly inclined, so that they will drain completely. The bottom of each tank is occupied by a filter about 6 inches thick, composed as follows: Light strips of three-quarter inch wood are first laid in the bottom of the tank at intervals of about one foot. Across these strips are laid six inch boards, leaving cracks of an inch or more between the boards. On top of this loose floor are placed coarse lumps of quartz, and on top of this again finer quartz material, until a total depth of about five or six inches is obtained. Finally, this "sand-filter" is covered by another loose floor; the boards lying crosswise to the loose floor beneath, and pretty close together. This upper floor is intended merely to furnish a shoveling surface, so as to permit the removal of the leached ore from the tanks without disturbing the filter.

The ore to be chloridized must be damp (about six per cent. moisture). The working test is, to take a handful of the ore and squeeze it, then open the hand, and if the lump immediately begins to crumble and fall apart (not run), the ore has the requisite amount of moisture.

The damp ore is screened into the tanks, so that it will lie as loosely as possible, and facilitate the penetration of the chlorine gas. A coarse screen of one-half inch mesh is used for this purpose.

The tanks are only filled up to within about three inches of the top. This is to insure that the entire contents of the tank are covered by water in the subsequent leaching, otherwise there will be great difficulty in washing out all the soluble gold.

As soon as the tanks are filled as stated, they are ready for the introduction of the chlorine gas. This is introduced into the bottom of the tank from two opposite sides, and is continued until ammonia held over the ore gives off dense fumes of ammonium chloride. This usually takes about four hours. When this point is reached, covers are placed on the tanks and the cracks are luted with a mixture of leached ore, bran, and water. The gas generators, of which there are two employed at one time in charging a tank, are allowed to work on until they are exhausted; then they are disconnected and the holes in the tank are plugged.

The tank is usually charged with gas in the morning, and is left standing for two days. On the third day, the ore is leached. The tank is first filled with water and allowed to stand a few minutes, so that the water may penetrate all the ore. If no more water is absorbed, the liquor is drawn off at the bottom, care being taken to keep the tank full of water during the entire operation, which takes from four to five hours.

In charging the tank, a gunny sack is laid on top of the ore, where the wash-water is afterward to be introduced, in order to better distribute the water in the tank and prevent its washing and packing the ore.

The liquor from the leaching vats is conducted to settling or storage tanks, and about 40 pounds of sulphuric acid (66 degrees B.) is added. (Experience has shown this addition of acid to be advantageous in obtaining a clean product in the subsequent precipitation. The chemical reaction is, however, by no means clear.) It is usually allowed to stand for twenty-four hours, but two hours are quite sufficient. It is then run into precipitating tanks, and the gold is precipitated by a solution of sulphate of iron. The iron solution is added until, after stirring, a further addition produces no purple color. After the gold is precipitated, it is allowed to stand two or, if convenient, three days to settle; then the supernatant liquor is drawn off with siphons into a second settling tank, where any gold that may have been drawn off by the siphons has a second opportunity to settle. The liquor stands in this tank until it is necessary to run it off to make room for another charge. Very little gold is found in this tank, and it is therefore only cleaned out once during the year. In the mean time, fresh liquor has been run into the precipitating tanks upon the gold already precipitated there. In this way, the gold is allowed to accumulate until the semi-monthly clean up. Except when it is necessary to have them open, the precipitating tanks are kept covered and locked.

In making the clean up, the supernatant liquor is siphoned off, the gold gathered up and placed in a filter of punched iron lined with a sheet of ordinary filter paper, and washed with water until all the acid and iron salts are removed. It is then dried, melted in crucibles, and cast into bars.

The works extract from 95 to 96 per cent. of the assay value of the concentrated, sulphides. Two men, on day shift, attend to all the work of handling the ore after it is washed (the leaching, etc.). The head man receives $3, the other $2.50 a day. Owing to the limited amount of ore allotted to the works, only three tankfuls are leached every four days. The men, however, are employed steadily.

The sulphate of iron is manufactured on the spot. For this purpose, an ordinary wooden tank about 4 feet by 4½ feet, standing outside the building in the open air, is used. The tank is kept full of water and supplied with old scrap iron *ad libitum*, and for each charge to be precipitated about 40 pounds of acid are added to the tank.

The precipitating tanks, which are of wood, are protected from the action of the acids by a coating of "paraffin paint."

I append an itemized statement of the cost of handling the ore. The basis of figuring is 100 tons of ore per month of 30 days. Consumption of chemicals in the leaching department, 24 days in each month.

Roasting:		
Three men, at $2.50 per day, for 30 days........................	$225.00	
1¾ cords wood, at $4.25 per day, for 30 days........................	223 13	
54 pounds salt, at ¾ cent per day, for 30 days........................	12.15—	$460.28
Generator: The charge is manganese, 30 pounds; salt, 34 pounds; sulphuric acid, 60 pounds; therefore, for two generators:		
Manganese, 60 pounds per day, 24 days, at $47 per ton........	33.84	
Salt, 68 pounds per day, 24 days, at $15 per ton................	12.24	
Acid, 120 pounds per day, 24 days, at $60 per ton................	86.40—	132.48
Acid for settling tanks (40 pounds) and for sulphate of iron manufacture (40 pounds), 24 days....		57.60
Wages of leachers, at $5.50, for 30 days........................		165.00
Salary of foreman........................		125.00
Total........................		$940.36

Or, per ton of concentrates, $9.40 3-10.

* A paper read before the American Institute of Mining Engineers, Bethlehem, Pa., May, 1886, by George W. Small, E.M., Oconomowoc, Wis.—*Eng. and Min. Jour.*

PEROXYD OF HYDROGEN.

PEROXYD of hydrogen, or oxygenated water, was first introduced by Hopkins & Williams, of London, about twelve years ago, but subsequently improved and manufactured at a price which allows of its more general employment, by the Emken Chemical Company, New York. The virtues of this product, says the *Textile Colorist*, and its superiority as a bleaching agent over chlorine in any form, by its perfect safety, render its exclusive employment in bleacheries only a question of time, which will doubtless be settled in the near future, and every communication regarding it has, therefore, special interest for the industries.

William Lindner, in the *Chemiker Zeitung*, says: Among the various methods of production of hydrogen peroxyd, that with barium peroxyd has been found to be the best. The barium peroxyd, however, must be procured in the highest state of purity possible, and used in a finely divided condition. Purity of the barium peroxyd is the condition of a high percentage yield, which cannot be obtained by barium peroxyd which is only slightly impure. It is obtained in a finely divided state by repeated steeping in water, removing the caustic baryta possibly present by washing with water, and passing through fine wire sieves. The residue is then collected upon filters and made into a kind of paste. Hydrofluoric acid, hydrofluorsilicic and phosphoric acids, or any other acids may be used, the two last named in preference to the rest. The acid being suitably diluted, the barium peroxyd paste is introduced, but very slowly, at a temperature which must in no case exceed 20 deg. C. (68 deg. F.), and under *constant stirring*, which is necessary to prevent the peroxyd from remaining in contact with neutral portions of the solution, as such would cause immediate decomposition, and, consequently, a diminished yield. Finally, when hydrofluorsilicic acid is used, the addition of phosphoric acid is indicated as decidedly advantageous, as it precipitates the oxyds of iron and alumina, small quantities of which are always present in barium peroxyd, as phosphates. The solution being sufficiently neutralized, it is filtered, the residue washed with several waters, and the latter mixed with the filtrate are made to a three per cent. solution, from which the baryta is best precipitated by sodium sulphate. From the precipitate the acid is easy to recover, but before using it again it must be very carefully purified, because any impurity is liable to affect the amount of production. The value of any peroxyd of hydrogen can be best ascertained by titration with a solution of 7·9 grm. potassium permanganate in 1 lit. water. If, however, no particular accuracy is required, the following method is recommendable, which, with a little practice, gives results within 1-10 per cent., and can be carried out in a few minutes. In a graduated test tube, 2 c. cm. of peroxyd of hydrogen are measured off, 5-6 drops hydrochloric acid are added, and then, under continual agitation, a solution of permanganate of potash is added until the color of the liquid remains red or brown. Generally, a peroxyd of hydrogen of three per cent. will be increased to about 17 c. cm. during the operation, that is, 5 c. cm. solution of potassium permanganate correspond with about 1 c. cm. peroxyd of hydrogen.

M. Contamine, in the *Bulletin de la Société Industrielle de Rouen*, recommends for use in factories the following method to rapidly ascertain the strength of a bleaching bath. After neutralizing the oxygenated water with ammonia, 1 or more c. cm. of it are placed into a 0·50 m. gas test-tube graduated in 1-10 c. cm.; ordinary or distilled water is added up to 30 centimeter, and some potassium permanganate crystals, wrapped in a piece of tissue paper, are introduced. The tube is then immediately closed with the thumb and shaken, when all the oxygen is evolved; it remains only to turn over the test tube and read off the volume of gases (oxygen and air). The difference between the space originally occupied by the air, 50—30 = 20 c. cm., and the new space (volume) occupied by it gives the quantity in centimeters of oxygen contained in the oxygenated water. This volume of 20 m. air left in the tube is necessary and sufficient to allow the observer to keep his finger upon the tube (notwithstanding the pressure of the gas) until all the oxygen is set free, which is the case when the brown color of the sesquioxyd of manganese, produced by the decomposition of the permanganate of potash by the oxygen into sesquioxyd of manganese, oxygen, and potash, is obliterated by the red color of the permanganate in excess.

Low temperature and absence of light are the well-known requirements for preserving peroxyd of hydrogen, and if carefully observed, a good product kept in glass carboys will scarcely loose 0·1 per cent., under these conditions, in three months. This preservation, however, depends largely upon the free acid present; phosphoric acid serves this purpose best, while sulphuric acid, though otherwise recommendable, gives less satisfactory results. A hydrogen peroxyd which contains another than phosphoric acid can be rendered more stable, therefore, by the introduction of a little sodium phosphate, whereby free phosphoric acid is produced in the liquor. Peroxyd of hydrogen, if well made, can not only be well preserved in glass vessels, but may be packed in properly tarred casks, and large cargoes have already been shipped in this manner from Europe to this country. It keeps also well in bright tin vessels, either burnished or covered with amber varnish.

In the use of peroxyd of hydrogen, the methods described by P. Ebell are generally preferred. (See *Text. Colorist*, vii., p. 145.) To bleach dense substances, such as ivory, bone, etc., an acid solution is used without any addition, in which the material is laid down until, after drying, it shows the desired degree of whiteness. Fine ivory in large pieces is rarely bleached, as its peculiar yellowish color is preferred; while small pieces, such as piano keys, which are wanted as white as possible, are bleached in great quantities. Sunlight, however, is always required to assist in the process and to act upon the material simultaneously with the peroxyd of hydrogen; this work is, therefore, principally done in summer. The more or less reddish pieces of ivory, which are cut from the tusk closely under its external crust, are also made useful by bleaching with peroxyd of hydrogen. Bone behaves similar to ivory, and is rather more sensitive to the action of the peroxyd; and even horn can be bleached to a certain extent, that is, if light colored, to a light gray, while it is impossible entirely to destroy the color of dark brown horn. Fibrous material is best bleached by a slightly ammoniacal solution, and the action is so rapid that hair, *e. g.*, can be bleached, for experimental illustration, at a lecture. If, on the same principle, the material is steeped in acid peroxyd of hydrogen, slightly squeezed, and exposed in a closed vessel to ammonia vapors, the beginning of the bleaching process may at once be observed, and by repeating the operation the substance can be completely bleached. Tussah silk, as we have heretofore observed, is best bleached by this process, but must be stretched upon frames, to prevent the loss of gloss and assuming a woolly appearance by the repeated handling. For bleaching of wool, peroxyd of hydrogen has recently been strongly recommended. H. Loebner says that the acid solution directly applied gives good results, and a Parisian manufacturer sends it out with an "alkaline reagent," which is nothing but a solution of sodic waterglass. H. Schmitt states its usefulness, in some cases, for discharge printing; and though the best method of its application is not yet established, the introduction of peroxyd of hydrogen in the print industry, and elsewhere, is no longer doubtful. For restoring to whiteness cotton, linen, woolen, and silk goods which have become yellow by age, hydrogen peroxyd is the least injurious bleaching medium. For the vegetable textiles, 2-5 per cent. commercial peroxyd are added to the water in which the material is steeped, and a little ammonia is added; for the animal fibers, silk in particular, the bath must be stronger. In scouring and washing, to remove stains of wine, ink, fruit juices, etc., it is a most handy and effectual detersive body; if the spot is moistened with peroxyd of hydrogen, and a drop of ammonia added, the stain is rapidly removed.

Peroxyd of hydrogen is, besides, recommended for many other purposes—as a disinfectant for wounds, by Péan and Baldy; as an antizymotic, in brewing, by Best, Reynard, Pommer, and Ebell, though their opinions are opposed by Weingaertner and Kranbauer; and its usefulness in preserving fruits, meats, vegetables, etc., is very probable. Finally, it may be employed as the source whence to obtain a regular stream of pure oxygen.

ACTION OF CERTAIN ACIDS, ALKALIES, AND SALINE SOLUTIONS UPON METALS.

WE have here an examination of the action of ordinary sulphuric acid upon cast iron. The conclusion reached is that at ordinary temperatures, and with exclusion of air, the action of sulphuric acid, pure or commercial, at strengths of 66° to 50° B., is very insignificant, and noteworthy differences as regards the various qualities of iron could not be distinguished. At the boiling point of water the action is much greater, that of acid at 66° B. being the slightest, that of acid at 60° B. one and a half times greater, and that of acid at 50° B. three times greater.

The differences at the boiling points of the acids are much more decided. Acid of 66° B. has little more action at its boiling point (295°) than at 100°; acid of 60° B. acts at its boiling point (200°) on the average fourteen times stronger than at 100°, and twenty times stronger than the 66° acid at 295°. The 50° B. acid, which at 100° acts twice as strongly as that of 60° B., acts at its boiling point (147°) less strongly than that of 60° at 200°.

In the second chapter the author examines the action of monohydrated sulphuric acid upon cast iron, wrought iron, copper, and lead. At common temperatures and at 100° there is very little action, either upon cast or wrought iron, if air is excluded. Copper and lead are strongly attacked at common temperatures, lead more than copper. At 100° lead is scarcely more affected than at 20°, while copper enters into violent reaction, with escape of sulphurous acid.

The third chapter gives an account of the saturated solutions of sodium chloride and ammonium chloride upon the same metals. With sodium chloride the attack is slight in all cases, but quite perceptible, especially on cast iron, and at higher temperatures on lead. The action of ammonium chloride is much stronger. Contrary to the common opinion, lead is much more attacked in the cold by a strong solution of sal ammoniac than iron. At a boiling heat it resists far better than iron, but far worse than copper.

Lastly, we find an account of the action of caustic soda-lye, sodium sulphide, and sulphate upon the same metals. Caustic soda has little action upon iron at 15° and 100°, but more upon wrought iron than cast iron. Upon copper the action is more considerable, and upon lead still more so if the lye is dilute. Sodium sulphide, even in dilute solution, has a much stronger action upon iron and copper. Upon lead the action is slight, even at 100°. Sodium sulphate has little effect upon copper and lead, but its action upon iron is considerable.—*G. Lunge.*

ON THE FORMATION OF AMMONIUM THIOSULPHATE IN GAS GENERATORS.

By Dr. H. ENDEMANN.

MR. A. FABER DU FAUR, a metallurgist of this city, erected a short time ago a gas generator in which air forced through anthracite coal was converted into a mixture of carbon monoxide and nitrogen, which was to be used for certain metallurgical operations.

As a blast for the generators a Korting steam blower was used, so that a certain amount of steam entered with the air. This steam was quite wet, to such an extent that the under part of the generator was in a short time blown cold, while the heat was developed only in the upper parts. The gases so produced passed from the generator through a 30 inch main of $\frac{3}{16}$ inch boiler plate, and thence through branches to places where the gas was to be utilized. In the main pipe, as well as in the branches, much liquid condensed, which was drawn off from time to time, and where the liquid had a chance to pass through joints long stalactites of light pink color were formed.

I have examined these stalactites, and found that they consisted principally of ammonium thiosulphate. The sulphur for this combination came evidently from the anthracite coal, while the nitrogen of the ammonium was derived from the air and the hydrogen from the water.

I look upon the formation of this compound as being as follows:

The upright generators contain layers of anthracite coal in different stages of decomposition and combustion. The lower, hottest, layer of the coal produces at first carbon dioxide, which in the upper layers is reduced to carbon monoxide. The pyrites of the anthracite coal is in the upper layers simply decomposed by heat into FeS and S. This sulphur passes off with the gases. The FeS in its downward march encounters then free oxygen, and oxide of iron and sulphur dioxide are formed, which latter passes on likewise with the gases. Some of the water is decomposed by the carbon of the anthracite coal, forming hydrogen, a part of which may be found in the gases, while another portion in the presence of atmospheric nitrogen is converted into ammonia. Along with the gases, carbon monoxide, hydrogen, and nitrogen, we have therefore a number of condensable substances to pass into the main, namely, water, sulphur, sulphur dioxide, and ammonia.

When condensation takes place, these substances unite as follows:

$$SO_2 + S + H_2O + 2NH_3 = SO_2 \begin{matrix} \diagup S-NH_4 \\ \diagdown O-NH_4 \end{matrix}$$

The product, with an excess of water, forms a solution.

There is nothing especially new in the reaction. That alkaline sulphites in solution dissolve sulphur, forming thiosulphates, is known. The formation of ammonia from nitrogen and hydrogen at great heat is likewise conceded, and it may be even considered more likely of formation, since the hydrogen is here in the nascent state, while experiments regarding this reaction were made with mixtures of gases. But even the fact that during the combustion of non-nitrogenous compounds in air ammonia is formed is established.

It is likewise an established fact that iron pyrites loses first one atom of sulphur when heated in the absence of oxygen, and the second atom only during true combustion.

The gas producer has since been altered by the introduction of a fan blast in the place of a steam blast, and the condensation and formation of this by-product has ceased. A white dry powder, which is now found in the flues, proved to be nothing but ashes, which had been carried along by the rapid movement of the gases.

BICHROMATE OF SODA.

IN the manufacture of this product, the neutral chromate of soda (Na_2CrO_4) is first obtained by heating in a reverberatory furnace six parts chrome iron ore with three parts soda ash and three parts chalk. The mass is thrown in water while still hot, and the lye thus produced is evaporated to 112° Tw. in iron vessels, and then poured in leaden vessels to crystallize. A product is obtained of the formula $Na_2CrO_4 + 10H_2O$, which, if dried in a stove at about 30° C., loses all its water of crystallization, and gives a Canary yellow powder.

The bichromate is obtained from this neutral chromate by dissolving in hot water, and then add sufficient sulphuric acid to convert it into the bichromate, which is seen by means of iodide starch paste, which is turned brown at the end of the reaction; then enough neutral chromate is added to the solution so as to obtain a product containing 72 per cent. chromic acid. After cooling, when the sulphate of soda crystallizes out, the liquor is removed and evaporated to dryness in iron boilers by constant agitation. The ultimate product, which is a mixture of the bichromate with the neutral salt, is less hygroscopic than the pure bichromate, which is thus obtained in the form of egg sized lumps, which, being ground, forms then the commercial article. It is interesting to note that the bichromate of potash is less poisonous than the sodium salt. The commercial bichromate of soda contains about 72 per cent. chromic acid.—*N. Walberg, in Dingler's Polyt. Journal.*

AN ACETIC FERMENT WHICH FORMS CELLULOSE.

By ADRIAN J. BROWN, Chemical Society.

THE acetic ferment is well known as the "vinegar plant," or "mother." Pure cultivations of it were made by a combination of the "fractional" and "dilution" methods, and also by growing it in a solid gelatin medium. The mode of growth of the tough gelatinous membrane of the ferment is described, its general appearance being very similar to a soft animal membrane. The membraneous growth of the "vinegar plant" is the only form which it assumes, no matter how the conditions are varied. *Bacterium aceti* never assumes this form; moreover, the "vinegar plant" gives all the chemical reactions of cellulose, but are not yielded by any form of *B. aceti*. The two ferments are, therefore, specifically distinct. The morphology of the ferment is described, and also its fermentative actions. The latter, so far as examined, are similar to those of *B. aceti* (comp. *Trans.*, 1886, 172), viz., ethylic alcohol is oxidized to acetic acid, and the acid so formed is afterward decomposed. Dextrose yields gluconic acid, and mannitol is converted into lævulose. Like *B. aceti*, also, it had no fermentative action on cane-sugar or lævulose.

Treatment of a membrane of the "vinegar plant" by H. Müller's bromine method leaves a film of pure cellulose of the same shape and character as the original membrane. The reactions of this cellulose are given, showing it to be ordinary cellulose like that from cotton wool.

The formation and use of cellulose by a simple cell plant is of interest in connection with the important part this body plays in the more highly organized plants. Experiments were, therefore, made to determine from what bodies the "vinegar plant" forms its cellulose. Cane-sugar, starch, and ethylic alcohol are not converted into this body; dextrose, however, can be so converted. In this latter case, therefore, the cells of a ferment have a double action upon the sugar, viz., the production of gluconic acid and the building up of cellulose. The latter action, however, cannot be considered one of fermentation.

Mannitol and lævulose are converted into cellulose, and favor the growth of the ferment more strongly than dextrose.

The usual method of preparing "home made" vinegar, by means of the "vinegar plant," is to introduce a

membrane into a solution of cane-sugar. The pure ferment has no action on this sugar, but the ordinary impure ferment used contains yeast cells, and these invert and ferment the sugar, so preparing alcohol for conversion into vinegar by the acetic ferment.

The name *Bacterium xylinum* is suggested for the "vinegar plant."

DISCUSSION.

Mr. Warington, after noticing the remarkable formation of cellulose from lævulose, said that it would be important to ascertain, if possible, at what stage oxidation sets in. Recent experiments by Muntz clearly show that organisms may promote oxidations which cannot be of service to the life of the organism, and which, therefore, must be regarded as unessential thereto.

The president said that it had hitherto been always supposed that cellulose was the very foundation of all vegetable cells, and it was, therefore, particularly interesting to have it established that certain bacteria did not contain cellulose.

NOTES ON THE INDENTIFICATION OF ALKALOIDS AND OTHER CRYSTALLINE BODIES BY THE AID OF THE MICROSCOPE.

By A. PERCY SMITH, F.I.C., F.C.S.

THE number of cases in which a crystalline substance can be identified by the microscope alone is extremely limited, but as a test of purity, microscopical investigation has a very wide application. When we are dealing with a substance that, when pure, crystallizes in a definite form from any particular solvent, it is manifest that any departure from that form would lead to the suspicion of adulteration.

Again, if we take such a substance as bark, or opium, it is quite possible to distinguish from each other the various alkaloids which it contains. Besides the form assumed by the free base, it is of importance to convert it into a salt, as there is frequently a marked departure in the form of the crystals, *e. g.*, quinidine and quinidine sulphate; cinchonidine and cinchonidine sulphate. There may be cases in which the salt and the base possess the same crystalline form. I have recently met with one in cocaine which, as well as the hydrochlorate, crystallizes in long needles radiating from a central nucleus, aggregated at angles of 90°, 180°, 270°, and 360°.

Some experience is necessary in selecting the most suitable solvent from which to crystallize an alkaloid, as the duration of the evaporation may have a marked effect upon the form of the crystals. In some cases, evaporation may be accelerated by the aid of heat; in others, such a proceeding is fatal to success. The addition of alcohol to ether, and of water to alcohol, appears to be the best means of retarding the process when necessary. To take the case of cocaine. From chloroform no crystals are deposited. From ether they are ill defined; but from alcohol, allowing evaporation to proceed very slowly, we get the best results.

I employ always polarized light by which to view the crystals, either with or without the addition of a selenite plate. Here, again, the duration of evaporation has a marked effect, also the strength of the solution. If the substance is deposited in a thin film, it may be altogether invisible without polarized light. Thick crystals frequently produce color without the selenite, and those that are very thick may depolarize without any coloration. This being borne in mind, no difficulty is experienced in practice, as it is easy to compare with an alkaloid of known purity crystallized under the same conditions.

In the accompanying plates, I have endeavored to give a representation of various substances crystallized under the best conditions, with the name of the solvent and the linear magnification. The letter B signifies a black field (ordinary polarized light), and V a violet field produced by the selenite. In many cases, I have found it difficult, if not impossible, to give a faithful drawing, but that is of slight importance, since any one who makes use of this method would naturally prepare his own slides for comparison.

BARK.

Quinine deposited from alcohol is granular.

Quinine disulphate crystallizes from alcohol in a network of fine needles.

Quinine disulphate mixed with a little iodosulphate is a gorgeous object, either with or without the selenite. It appears like an assortment of peacocks' feathers with the crests toward the center.

Quinine disulphate mixed with quinidine sulphate forms little feathery crystals, totally distinct from either of the salts crystallized alone.

A mixture of quinidine, cinchonidine, and cinchonine will not crystallize at all from alcohol, but dries up to a gummy mass.

Quinidine crystallizes from ethereal alcohol in stellate groups of monoclinic prisms, giving red centers and green at the ends (Fig. 1).

Quinidine sulphate has an entirely different form, each crystal assuming an independent hue (Fig. 3).

Cinchonidine crystallizes from alcohol in globular tufts of needles and in stellate groups, some of which exhibit a black cross on a white ground, resembling *somewhat* the grains of tous-les-mois; the larger groups show some color (Fig. 2).

Cinchonidine sulphate exhibits a marked change into pure colorless feathery sprays (Fig. 4).

Cinchonine. The crystals of this alkaloid, deposited from alcohol, are small, and resemble those of caffeine. The arrangement is, however, different. They are grouped in stars.

OPIUM.

Morphine crystallized from alcohol in minute needles (trimetric). They are characteristic, and show *faint* coloration (Fig. 5).

Meconic acid forms micaceous scales or small rhombic prisms, and is a unique object; the most usual form is a square with elongated corners, thus producing curved sides. The coloration is very varied, one may be like the French tricolor, another *quartered*, another showing two hues parted by a median line (Fig. 6).

Meconine crystallizes from water in a network of long needles, which are very large and of all conceivable colors (according to Watts, they are hexagonal prisms) (Fig. 9).

Narcotine separates from alcohol in separate crystals, each an independent hue (Fig. 7)

Codeine crystallizes from alcohol in large rectangular octohedra, truncated and modified in various ways. Also in a network of prisms, and other modifications. The selenite makes very little difference to the large crystals, as they are too thick to be affected by it (Fig. 8).

Papaverine. The crystals deposited from alcohol have a great tendency to arrange themselves in globular stars. Between these are seen badly formed prisms, generally four or five together, star-wise. They are colored (Fig. 10).

Thebaine. The crystals are very similar to those of elaterine, but are larger and better defined. They are square plates, and show no color without the selenite. (Fig. 11).

Narceine forms stellate groups of needles, which require the selenite to show color.

Then the horizontal and vertical needles assume complementary tints (Fig. 12).

An attempt was made to identify meconic acid by the above method, after extracting from an organic mixture, to which opium had been added, and which was successful. The process employed was as follows:

Boiled with alcohol and a little HNO_3 filtered, added water, distilled off alcohol, precipitated the meconic acid with $PbAc_2$, decomposed with H_2S, evaporated to dryness, and crystallized from alcohol.

The filtrate from the lead meconate was shaken with benzine, and the benzine residue crystallized from water and from alcohol. Long needles of meconine were easily recognized.

The benzine extract from the liquid made alkaline and the chloroform and amyl alcohol extract all yielded crystals, but they could not be recognized. All contained meconine.

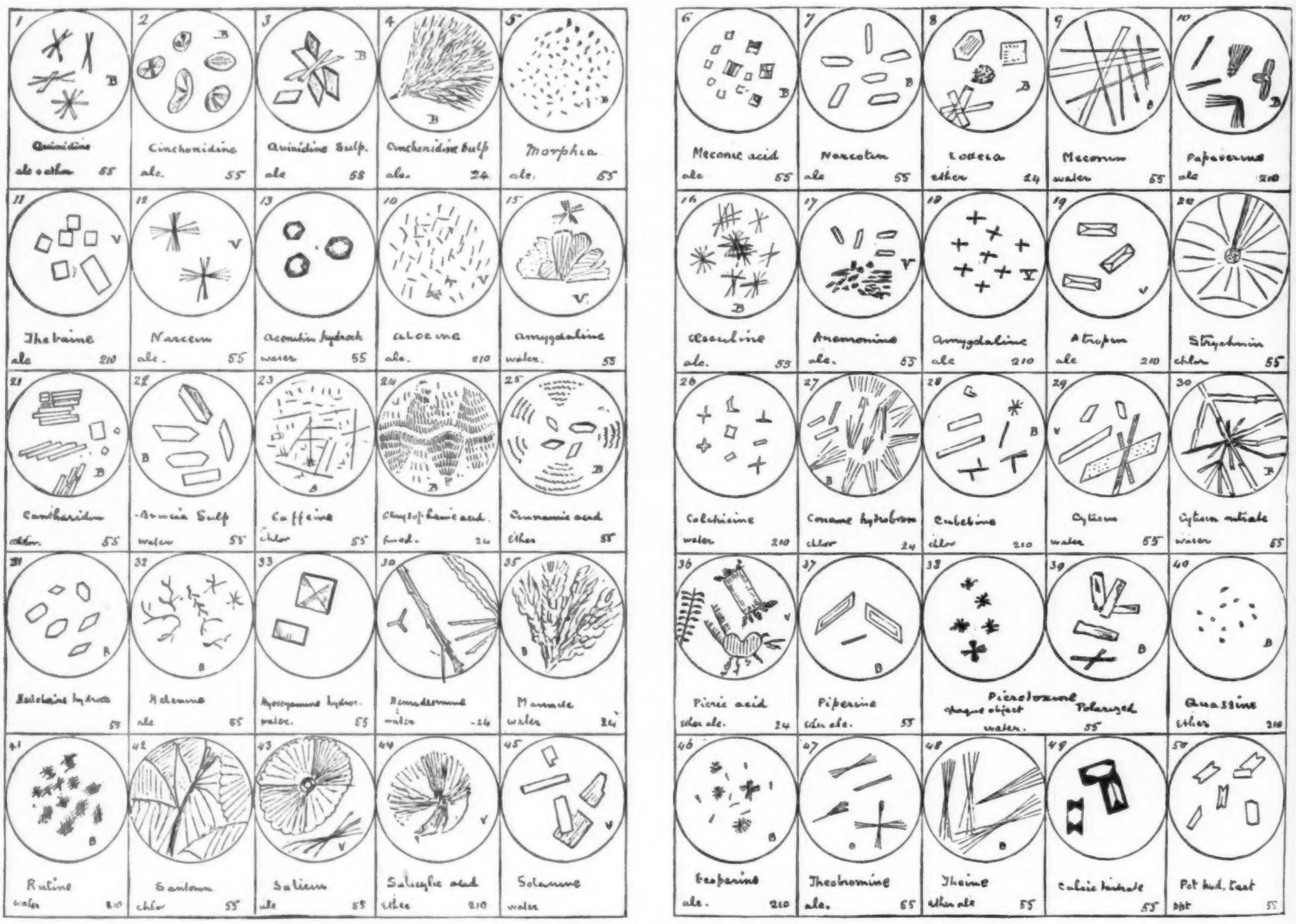
Aconitine does not crystallize from either alcohol, water, or petroleum ether. Its hydrochlorate crystallizes with great difficulty from water. A very lengthy evaporation is requisite. The plate shows the crystals viewed by ordinary light, without the polarizer (Fig. 13).

Aloeine crystallizes from hot alcohol in small, *yellow* needles, grouped in tufts, which depolarize very slightly. It may be viewed either as a transparent or opaque object. The plate shows detached crystals, seen with selenite (Fig. 14).

Amygdaline differs in appearance, according whether it is crystallized from alcohol or from water. From the latter, it forms large, feathery crystals, like the distended tail of a bird, and gives fine colors with the selenite. From alcohol, it forms small, ill-defined stars, the components of which exhibit complementary hues (Figs. 15 and 18).

Œsculine forms colorless needles, in stellate groups (Fig. 16).

Anemonine crystallizes from hot alcohol in moss-like forms, which depolarize completely, but give no color without the selenite. There are also some isolated crystals belonging to the trimetric system. (Decom-



MICRO-CRYSTALS.—BY A. PERCY SMITH, F.I.C., F.C.S.

posed into anemonic acid by boiling with alkalies.) (Fig. 17.)

Atropine is best crystallized from alcohol, when it forms a confused mass of prisms, each of an independent tint. Where the film is thin, it forms fan-shaped crystals. Without the selenite, the crystals merely appear a bluish white (Fig. 19).

Strychnine crystallizes from alcohol in long prisms; from benzine in polygonal plates, or six-sided prisms, not constant; from ether in dendritic forms, and sometimes prisms. Deposited from chloroform, the appearance is highly characteristic, forming rosettes, and various forms of great beauty. I have made no attempt to delineate the rosette with any approach to accuracy, as it is scarcely possible to copy it in pen and ink. It is probably too familiar to my readers to need description. I have succeeded in obtaining a film of strychnine, quite invisible with ordinary illumination. On introducing the polarizer, dark circular forms and ridges are made visible. When the selenite plate is added, the most gorgeous colors are obtained.

I regard the appearance of strychnine as so characteristic as to obviate the necessity of using chemical tests. I have frequently extracted the alkaloid from organic mixtures, and identified it in this way without going to the trouble of purification from dirt. Of course, I presuppose the absence of other substances that can enter into combination. There is only one other alkaloid that can, *by any chance*, be mistaken for strychnine, and that is santonine; but, in following Dragendorff's scheme, they would be extracted by different solvents. Besides, there is a considerable difference in the appearance when carefully examined (Fig. 20).

Cantharidine crystallizes from chloroform and from alcohol in right angled four-sided prisms. Those crystals which depolarize without color give clear tints with the selenite, showing the evenness of their surfaces. There is a tendency to form stars; the larger crystals are colored without the aid of the selenite. The appearance is quite characteristic, and can be confounded with no other alkaloid I have as yet examined (Fig. 21).

Brucine sulphate is best crystallized from water. The crystals depolarize chromatically without the selenite. The free base does not crystallize so well (Fig. 22).

Caffeine crystallizes from chloroform in a network of needles. The crystals are thicker in the middle than at the ends. For the most part they are brilliantly white, but some of the larger show color on account of their greater thickness. When the selenite is used, each crystal assumes an independent tint (Fig. 23).

Chrysophanic acid is most characteristic when fused in a thin film, and allowed to solidify, when it forms moss-like aggregates of laminar crystals which depolarize, retaining their yellow color (Fig. 24). It crystallizes in six-sided monoclinic prisms from benzine.

Cinnamic acid crystallizes from ether in perfectly formed monoclinic prisms of varying hues. If the solution be too concentrated, the crystals set in a mass, showing no color, but arranging themselves in concentric waves (Fig. 25).

Colchicine crystallizes with extreme difficulty from water. The varnish-like residue left on evaporation, if kept in a dry place, will ultimately show the crystals at the margin (Fig. 26).

Coneine hydrobromate crystallizes from chloroform in white needles (Fig. 27).

Cubebine.—The best solvent for cubebine is chloroform, but the crystals do not depolarize well, and are best viewed as transparent objects (Fig. 28).

Cytisine is soluble in water and dilute alcohol, but not in ether, chloroform, benzol, or bisulphide of carbon. It crystallizes well from water, and when the selenite is used, each crystal is of an independent tint. Where the crystals cross each other at right angles, complementary tints are assumed (Fig. 29).

Cytisine nitrate crystallizes from water in branched prisms of very variegated hues. It is a very pretty object (Fig. 30).

Digitaline.—I have been unable to obtain this alkaloid in a crystalline form.

Elaterine deposited from chloroform is precisely similar in form to thebaine, *q. v.* The crystals are somewhat smaller and require a power of 210 diameters. With the selenite, each crystal is an independent tint (see Fig. 11).

Helenine can scarcely be said to crystallize at all. The alcoholic residue refuses to dry completely at ordinary temperatures. The crystals are mere arborescent sprays (Fig. 32).

Helleborine crystallizes as the hydrochlorate from an acid solution, by dissolving helleborine in HCl and allowing it to evaporate spontaneously. The crystals are white under polarized light (Fig. 31).

Hyoscyamine crystallizes as the hydrochlorate from water. The crystals are best viewed by ordinary light, and resemble crystals of common salt (Fig. 33).

Hemidesmine crystallizes from water in needles of a peculiar shape—spiked—branching and flattened (Fig. 34).

Mannite crystallizes from water in feathery sprays, resembling those of cinchonidine sulphate, *q. v.* (Fig. 35).

Picric acid. The crystals of picric acid deposited from ethereal alcohol are yellow by reflected light, but under the polarizer present most remarkable forms. The crystals are rectangular and fringed with the most curious arborescent processes. Some forms resemble moss, others branches of fir. Altogether it is a unique object. Best seen with selenite (Fig. 36).

Piperine crystallizes well from a mixture of alcohol and ether, in four sided monoclinic prisms. The crystals appear as if marked upon their surface, owing to varying thickness, or partial adherence of other crystals (Fig. 37).

Picrotoxine, both from alcohol and from water, forms very ill defined crystals (four sided prisms) grouped in stars. These, for the most part, do not depolarize, because they are globular in form, and, consequently, nearly opaque. A few isolated crystals depolarize (Figs. 38, 39).

Quassine forms very minute crystals when deposited from ether. I am not quite certain to what system they belong. A power of 210 is not sufficient to determine this (Fig. 40).

Rutine crystallizes from hot water in a network of fine needles (Fig 41).

Santonine when crystallized from chloroform bears a faint resemblance to strychnine. It forms large, feathery rosettes, which differ from those of strychnine in possessing a crystal for a nucleus. Like strychnine, the films show no color without the selenite (Fig. 42).

Salicine crystallizes from alcohol in long needles, rosettes, and feathery tufts, and forms a striking object with the selenite. The rosettes are colored complementary in a cruciform direction, and the nucleus is also complementary in the opposite direction (Fig. 43).

Salicylic acid crystallizes from ether in rosettes somewhat resembling those of salicine, but the nucleus is a point, and not a circle, as in the latter. It forms an exceedingly pretty object with a low magnifying power (Fig. 44).

Solanine is sparingly soluble in water, and crystallizes therefrom. It is soluble in alcohol, but does not then crystallize. Viewed with the selenite, each crystal assumes an independent tint (Fig. 45).

Scoparine.—The only method of obtaining crystals is to dissolve in AmHo and precipitate with HCl, when the crystals are seen immersed in a jelly, or by dissolving in hot alcoholic ammonia and allowing to cool very slowly (Fig. 46).

Styracine crystallizes from slow evaporation of ethereal or alcoholic solution in arborescent forms.

Theobromine is by no means a show object for the polarizer, the crystals are very bushy, and not sharply defined like those of theine (Fig. 47).

Theine crystallizes from ethereal alcohol in long needles, an aggregation of imperfectly formed stars (Fig. 48).

Calcic tartrate.—If calcic citrate, which is not crystalline, be contaminated with the tartrate, it may be easily detected by the aid of the microscope (Fig. 49).

Potassic hydric tartrate.—The plate shows the crystals as precipitated from potassic chloride by sodic dihydric tartrate (Fig. 50).

EXPERIMENT WITH A MIXTURE OF ALKALOIDS.

In order to subject the microscopic method of identification to a severe test, the following mixture was made:

Morphine, narcotine, codeine, narceine, papaverine, thebaine, meconine, meconic acid, cinchonine, cinchonidine, quinidine, quinine sulphate, atropine, brucine sulphate, strychnine, santonine, cantharidine, theobromine, theine, piperine, salicine, picrotoxine, coneine, hydrobromine, aloeine, and picric acid.

This was treated *a la* Dragendorff.

The petroleum ether extract from the acid solution was recrystallized from ether, and yielded crystals recognized as those of piperine, and picric acid.

The benzole extract from the acid solution was recrystallized from ether and from chloroform, and yielded crystals of picric acid, santonine, aloeine, and cantharidine.

The chloroformic and other extracts yielded crystals which could not be identified, with the exception of narcotine.

This experiment was really too severe a test. It is unnecessary to state that no such admixture would occur in practice.—*The Analyst.*

TESTING THE COMMERCIAL EFFICIENCY OF DYNAMO MACHINES.

By GISBERT KAPP.

ONE of the main features by which sound scientific engineering is distinguished from mere rule-of-thumb work on the one hand and from abstruse theorizing on the other hand is the application of rigorous methods of measurement to all problems connected with it. Until we know how to accurately measure, and express in well-known physical units, the forces and quantities we have to deal with in any piece of machinery, we cannot hope to thoroughly understand, and much less to improve, that particular piece of machinery. Dynamo machines have for some years past formed the subject of experimental investigation all the world over; and the amount of reliable information which has thus been accumulated is very considerable. Early experimenters labored under the disadvantage that the physical units on which their measurements had to be based were themselves not accurately known; and even the units of the present day are only approximately correct, though the possible error is so exceedingly small that for all practical purposes we may consider the present legal units for resistance, current strength, and electro-motive force as absolutely accurate. It is probable that the personal error of observation in reading measuring instruments is greater than the possible error in the accepted value of these fundamental units, and therefore no single reading could be made more accurate, even if the accepted units were absolutely correct. Of course, errors of observation can be greatly reduced by taking a large number of readings and correcting the differences by the method of least squares; and if that be done, the accuracy of our calculations would increase as the real values of the fundamental units became known. But it is never done in practical engineering work. We take as a rule single readings only, or at best the mean between two or three readings, and then the personal error is greater than the possible error in the accepted value of the unit. It is customary to regard 746 watts—that is, the electrical energy represented by a current of one ampere flowing for one minute under a difference of potential of 746 volts—as the electro-dynamic equivalent of 33,000 foot-pounds work done in one minute; in other words, 746 watts represented one horse-power. This value of the electro-dynamic equivalent is deduced as follows: We know that the dyne is that force which accelerates the mass of one gramme by one centimeter in one second. Gravity accelerates the mass of one gramme by g centimeters in one second, and the dyne can therefore be expressed as the product of the weight of one gramme and the ratio of these two accelerations. If we express g in meters per second, we thus find that one dyne equals $\frac{10^{-5}}{g}$ kilogrms. This is the unit of force. The unit of energy, the erg, is represented by the force of one dyne acting through a distance of one centimeter, and can be similarly expressed as $\frac{10^{-7}}{g}$ kilogrammeters. Since the unit of current is 10 amperes and the unit of electro-motive force 10^{-8} volts, and since the product of the two must be equal to the erg, we find that one watt equals 10^7 ergs, and that one kilogrammeter is equal to $\frac{1}{g}$ watt, and therefore 75 kilogrammeters, or one horse-power, is represented by $g \times 75$ watts. Now g, the acceleration of gravity, can be taken as 9·81, and hence $75 \times 9·81 = 736$ is the number of watts representing one horse-power of 75 meter kilogrms. per second. That is the usual French horse-power of 32,500 foot-pounds. The equivalent of the standard English horse-power of 33,000 foot-pounds would therefore be larger in the proportion as 33 is larger than 32·5. That gives the figure 746 above mentioned.

After these preliminary remarks we may confront our subject a little more closely. In the early days of dynamo machines, efficiency was quite a secondary question, and the output of a machine was hardly ever expressed as so many volt amperes or so many electrical horse-power, but it was simply stated that it could drive, say, three good arc lights, or four lights not quite so good. This was a rough and ready way of describing the machine, and although the output could be approximately guessed from the number of lamps, the size of the carbons, and the brilliancy of the arcs, nobody could form the least opinion on the question of power absorbed, even if he cared for it, which might be doubted. As long as the dynamo could be kept running, and as long as some light was produced, it was considered satisfactory.

The question of efficiency was first broached in connection with the electric transmission of power, but it was brought forward in a somewhat misleading way. In all probability, M. Marcel Deprez is to a great extent responsible for the loose way most electricians got into when talking about the efficiency of dynamos, and for the many absurd statements relating to the transmission of energy by dynamo machinery which are found in many of our best standard text-books. M. Marcel Deprez, in his lecture delivered at the Paris Congress of Electricians in 1878, and after him nearly every writer on the subject, argued in this manner: If we have two identical machines, one acting as a generator and the other as a motor, the energy required by the former and that given out by the latter is in either case equal to the product of current and electro-motive force.

Since the current is the same in both machines, the proportion between the electro-motive force in the armature of the generator and the counter electro-motive force in the armature of the motor represents also the proportion between the energy expended and recovered. If both machines are identical, the electro-motive forces are proportional to the speeds, and hence the ratio of speeds represents the efficiency of the system. Nothing could be more beautifully simple, but at the same time nothing could be so absurd as this statement. Say the two machines are series wound. Then the speed of the motor will be the greater, the smaller the current flowing through it, because a reduction of current results of necessity in a reduction of the intensity of the magnetic field, and that necessitates an increase of speed in order that the counter electro-motive force may balance the electro-motive force of the generator, proper allowance being of course made for the loss of electro-motive force occasioned by the resistance of the two machines and the line connecting them. Now assume this line to be leaky. In this case, part of the current sent out by the generator does not reach the motor at all, and consequently the field of the motor will be weaker than that of the dynamos. Thus the speed of the motor will be greater than would be the case were the insulation of the line perfect, and the very fault which naturally reduces the efficiency of the system has the effect of making the ratio of the speed higher than it would otherwise be. To determine the efficiency by simply taking the proportions between the speed of the motor and that of the generator is therefore absolutely wrong. But even if the line be perfect, this method is misleading. It will be evident that the ratio of speeds will be the nearer unity, the smaller is the loss of electro-motive force occasioned by the resistance of the two machines and of the line, that is, the smaller the current passing. But in this case the total amount of energy transmitted is also very small, and it may well happen that after deducting the energy required to overcome the mechanical and magnetic friction of the motor, nothing is left for useful external work. The actual efficiency of the whole system would therefore be zero, while the efficiency as estimated from the speeds appears to be a maximum.

The anomalies here set forth are all due to the fact that the commercial efficiency of the machine, whether generator or motor, has not been sufficiently distinguished from the purely electrical efficiency. It is very easy to determine the electrical efficiency of a dynamo. We have only to ascertain what is the electrical energy given out and what is the electrical energy developed in the armature, and to take the ratio between the two. All this is extremely easy, and requires no other apparatus than a Wheatstone bridge to measure the resistance of the different parts of the dynamo, and the usual current and potential indicators. The resistances once ascertained, the other measurements can be taken without in any way interfering with the working of the dynamo; and it is therefore but natural that the makers of these machines often make use of the term "electrical efficiency." But to the practical engineer the term has no meaning. He wants to know how much power he must provide to produce a given electrical output, inclusive of all losses, and he can only ascertain the power beforehand if he knows the actual commercial efficiency of the dynamo he is going to employ.

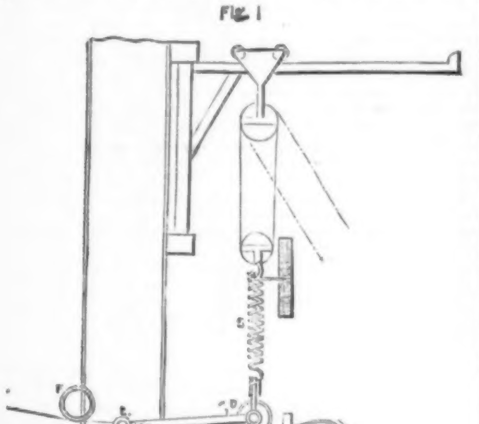
The usual way of measuring the commercial efficiency of a dynamo machine is by employing some kind of transmission dynamometer placed between the prime mover and the dynamo, and taking simultaneous readings of the energy transmitted and the electrical energy obtained. Now, every engineer knows that measurements of that kind are difficult to make, and require costly apparatus, especially if the power to be transmitted is considerable. Only the very best and most expensive forms of transmission dynamometer—such as Tatham's or Brackett's—give fairly accurate results, and a cheaper class of instrument would be perfectly useless, as its own error would probably exceed the difference between electrical and commercial efficiency which we wish to ascertain. It must be remembered that the commercial efficiency of the modern

dynamo is far greater than that of any other machine intended to convert energy from one form into another, and that the difference between an excellent dynamo and a fairly good one is reckoned by but a few per cent. in the efficiency. Hence a transmission dynamometer which may have an error of a few per cent. would be useless for our purpose, besides being, on account of its price, beyond the reach of most private individuals.

The difficulties which stood in the way of accurately determining the commercial efficiency of dynamo machines have recently been overcome in a most ingenious manner by a method devised by Dr. John Hopkinson. This method was first described by its inventor in the discussion following the paper on "Modern Continuous Current Dynamo Machines and Their Engines," read by the author in November last at the Institution of Civil Engineers. It consists, broadly speaking, in measuring not the whole of the power supplied to a dynamo, but the power wasted by two similar machines which are mechanically and electrically coupled, the one acting as a generator and the other as a motor. Dr. Hopkinson said: "Supposing 100 to be applied mechanically to the first machine, a power of 90 might be delivered by that machine to the second machine. Of that 90, 80 would in the second machine be converted into mechanical power, which mechanical power would be transmitted by the shaft to drive the first machine. There would remain then to be supplied only 20 for driving the whole combination. The quantities to be measured are then 20 and 90. Suppose that instead of measuring quite accurately, the measurements were 91 and 19·8. That 19·8 waste is divided between two—9·9 for each. Consequently, the first machine, apparently with an expenditure of 100·9, gives 91, so that although errors were made of 1 per cent. in each determination, in the final result of efficiency there is only an error of 0·2 per cent."

A short time ago, the writer had, in company with other engineers, an opportunity of seeing this method put into actual practice at the works of Messrs. Mather & Platt, in Manchester, who were kind enough to allow their visitors to repeat some of the experiments in order that this eminently useful method may be properly understood. The general arrangement of the plant may be thus described. It consisted of two Edison-Hopkinson dynamos, each designed for an output of 320 amperes at a pressure of 105 volts, when driven at 750 revolutions per minute. The shafts were connected by a flexible coupling which at the same time served as driving pulley, receiving motion by a link belt from a steam engine. The power supplied to this pulley could be measured by a transmission dynamometer of the original Hefner-Alteneck type, represented diagrammatically in Fig. 1, where B is

FIG. 1



the pulley connecting the shafts of the two dynamos. D_1, D_2 are loose pulleys supported by a frame, which is pivoted at C, and S is an adjustable spring suspended from a crane overhead. The vibration of the frame is reduced by a dash pot, L. The two ends of the belt are taken through guide pulleys, F F, so as to bring them parallel to the dynamometer. If motion takes place in the direction of the arrow, it will be evident that the strain in the lower belt must exceed the strain in the upper belt, and there will be a tendency to displace the frame downward. To counteract this tendency, the top of the spring must be raised until the pointer attached to the frame again returns to a zero mark which had been made while the system was at rest. It is easy to see that in this position the difference in tension between the two sides of the belt must, under all circumstances, be proportional to the increase of tension in the spring, which can be read off by an upper pointer and scale as shown.

The constant of the dynamometer is simply dependent on the geometrical proportions: it is 2·705—that is to say, to each division on the scale corresponds a tangential pull of 2·705 lb., acting at a radius equal to that of the pulley plus half the thickness of belt. To avoid the possibility of error in the geometrical determination of the constant, the latter was verified by combining the transmission dynamometer with an ordinary Prony brake, and comparing the power registered on the dynamometer with the power measured on the brake. One revolution of the pulley represents 3·63 feet advance of belt; hence $\frac{S \times 2{\cdot}705 \times 3{\cdot}63\, n}{33{,}000}$ = H. P. where S represents the tension of the spring in divisions on the scale, n the number of revolutions of the pulley per minute, and H. P. the horse power. We have also

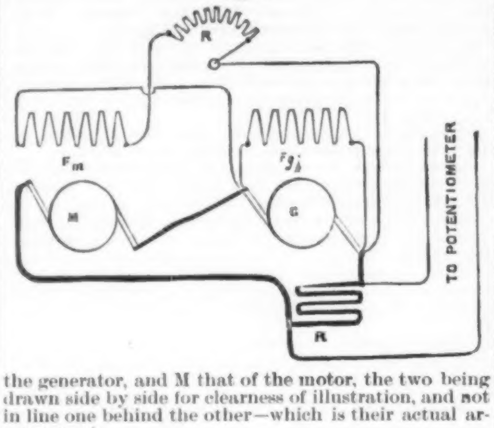
$$\text{H. P.} = 0{\cdot}000298\, n\, S.$$

It will be seen that n and S are the only mechanical data required. The electrical data are the current in the two armatures and the electro-motive forces created in the armature coils. We can, of course, only measure the external electro-motive forces, and must compute the internal electro-motive forces by adding the loss due to the resistances of the armatures. The two dynamos are shunt wound, and their resistances are as follows:

	Ohms.
Armature of generator...............	0·009947
Armature of motor...................	0·009947
Field magnets of generator	16·44
Field magnets of motor...	16·93
Resistance of leads, including platinoid coil..........................	0·00777

The electrical connections will be understood from the diagram, Fig. 2, where G represents the armature of

FIG. 2.



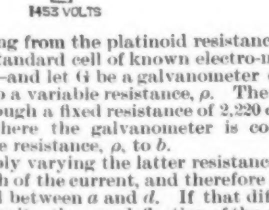
the generator, and M that of the motor, the two being drawn side by side for clearness of illustration, and not in line one behind the other—which is their actual arrangement.

$F\,g$ represents the field magnet coils of the generator, and $F\,m$ those of the motor, both being supplied with current from the brushes of the generator. Now, it will easily be seen that if the exciting current were alike in both cases, the counter electro-motive force created in M would be equal to the electro-motive force created in G, and no current would pass from one armature to the other. To allow a current to flow, it is necessary to slightly lower the counter electro-motive force of M, and this is done by reducing the exciting current in $F\,m$. The more we reduce the power of this magnet, the more easily will the armature of the motor be overpowered by the armature of the dynamo, and the more current will flow through both armatures, and the circuit shown in thick lines.

In order to regulate the exciting power of the motor field magnets, a rheostat, r, is inserted into the circuit, and by turning the handle of this rheostat one way or the other we can increase or decrease the main current flowing through the system, and therefore the total amount of mechanical energy supplied to the armature of the generator. The main current is measured by observing, on a potentiometer placed in a distant room, the difference of potential existing between the terminals of a platinoid resistance, R. This resistance is so low—0·0058 ohm—that the strongest current which is used during the range of experiments does not sensibly heat it. Moreover, the temperature correction of platinoid is so small that this resistance can be considered to be practically constant.

We therefore find the current by dividing the potential at the terminals of R by 0·0058. The potentiometer is arranged according to Poggendorff's method. Let, in Fig. 3, $a\,b$ represent the terminals of the two

FIG. 3



wires leading from the platinoid resistance R, let C represent a standard cell of known electro-motive force—1·453 volts—and let G be a galvanometer connected by a key, K, to a variable resistance, ρ. The current flows from a through a fixed resistance of 2,220 ohms past the point, d, where the galvanometer is connected, and through the resistance, ρ, to b.

By suitably varying the latter resistance we can vary the strength of the current, and therefore the difference of potential between a and d. If that difference be exactly 1·453 volts, then no deflection of the galvanometer will be observed upon depressing the key, because the standard cell just balances the electro-motive force between a and d. The difference of potental between a and b is, in that case,

$$E = \frac{1{\cdot}453\,(2{,}220 + \rho)}{2{,}220}$$

It will be noticed that this method can only be used if $E > 1{\cdot}453$. For smaller values a similar method is employed, but the standard cell is replaced by a secondary battery of known electro-motive force. It would be beyond the scope of this article to enter in detail into the different arrangements necessary. Those who wish for more information will find it in Mr. Kemp's excellent book on "Electrical Testing." The experiments were carried out in the following manner: The two dynamos were first run with the brushes off, neither of the two fields being excited. This gave the power necessary to overcome the friction in the bearings, the resistance of air, and that used up in the dynamometer itself. The next experiment was to excite the two fields separately, and run the dynamos still with the brushes off. This gave the power required to overcome the resistances just specified, plus the energy absorbed by revolving the two armatures in magnetic fields, or, as it might be termed, the power absorbed by magnetic friction. Roughly speaking, the magnetic friction was found to increase the power required for running empty by fifty per cent. The field coils were then coupled up, as shown in Fig. 2, and the proper power tests were made. In the following table are given some of the results obtained:

DYNAMOMETRIC EXPERIMENTS ON TWO SIMILAR EDISON-HOPKINSON DYNAMOS.

Scale divisions on spring balance..........	21·6	30	60	48·5	44
Revolutions per minute	808	802	764	808	808
Electromotive force at brushes of generator	....	....	110·12	118·87	124·41
Electromotive force at brushes of motor....	....	....	107 34	116·86	122 97
Electromotive force in armature of generator	....	....	113·79	121·56	126 40
Counter electromotive force in armature of motor...........................	....	....	103·78	114·29	121·12
Main current in amperes	...	...	358	258	186
Shunt current in field of generator........	....	6·9	6·72	7·21	7·57
Shunt current in field of motor	....	6 7	5·23	5·92	6·53
Current in armature of generator..........	...	....	370	271	200
Current in armature of motor..............	....	....	358	258	186
Horse power registered on dynamometer	5·18	7·17	13·66	11·70	10·60
Horse power converted in armature of generator	....	....	56·20	44·00	34·00
Horse power converted in armature of motor...............................	....	....	49·80	39·60	30·20

The horse power converted in the armature of the generator is that actually appearing in the form of internal electrical energy. The power which has to be supplied to the spindle is somewhat greater than the horse power converted, and the problem is to find how much greater; in other words, we want to find the efficiency of conversion. Similarly, the horse power converted in the armature of the motor is the electrical energy disappearing in the process of conversion into mechanical energy, which flows through the coupling back into the spindle of the generator. This power is somewhat smaller than that given in the table, because a certain loss occurs during conversion, and we want to find how great this loss is. Since the two machines are similar in size, we shall not commit any great error if we assume that the unknown loss in conversion is the same in both armatures. Let X represent the horse power thus lost. Then we have the following relation in reference to the experiment given in the third column:

Power supplied from the external source..........	13·66
Power supplied by the motor........	49·80–X

The sum of these two must be equal to 56·20+X, which represents the power actually supplied to the spindle of the generator. We have, therefore, the equation:

$$13{\cdot}66 + 49{\cdot}80 - X = 56{\cdot}20 + X,$$

whence

$$2\,X = 13{\cdot}66 + 49{\cdot}80 - 56{\cdot}20$$
$$X = 3{\cdot}63$$

It should here be remarked that in taking 13·66 as the power actually supplied to the whole combination we have made no allowance for the loss occurring in the dynamometer itself. Now, from the first column it appears that 5·18 horse-power are required to overcome the purely mechanical resistance of the dynamometer, the friction of armature spindles in their bearings, and the air resistance of the armatures. The latter two must properly be charged to the dynamos when determining their commercial efficiency, whereas the former should be deducted. It is extremely difficult to separate these losses, and we shall have either to neglect the loss in the dynamometer altogether, which would make the dynamos appear less efficient than they really are, or we must deduct the losses due to the dynamometer and the mechanical friction of the armatures together, which would make the dynamos appear more efficient than they really are. In the latter case the power applied externally would be $13{\cdot}66 - 5{\cdot}18\,\frac{764}{808} = 8{\cdot}76$, and the unknown quantity $X = 1{\cdot}18$.

This value agrees fairly well with the tests in the first and second column, where the increase of power due to the magnetization of the iron core of the armature had been directly ascertained. But there is one point which has not been taken into account, and which would slightly modify the efficiency when either of the dynamos was used in actual practical work. This is the increase of mechanical friction in the bearings due to the strain of the belt. It is a very different thing to transmit 10 horse power through a belt embracing three-fourths of the pulley and to transmit 60 horse power through a belt embracing, say, only four-tenths of the pulley. The strain in the driving end of the belt will, in the latter case, be probably ten times greater, and therefore the pressure of the spindle against its bearing and the power absorbed by friction will also be considerably increased. In order to make an allowance on this head, probably the fairest thing to do is to take the mean between the two values for X, and in this case we have:

Horse power in the belt driving the dynamo	58·60
Horse power delivered electrically at the terminals.........	53·60
Commercial efficiency, 91·5 per cent.	

Similarly we have for the motor:

Horse power delivered electrically to the terminals............................	53·60
Horse power obtainable at the belt.....	47·40
Commercial efficiency, 88·5 per cent.	

In this case the commercial efficiency is somewhat lower for the motor, which is probably due to the fact that the field magnets were not fully excited.

In the same manner we find the average value of X for the figures in the fourth column to be 2·36 and that for the figures in the last column to be 2·10. This gives for the dynamo:

Horse-power in belt driving the dynamo.......................	46·36 and	36·10
Horse power delivered electrically at the terminals...........	42·00 "	30·40
Commercial efficiency	90·6% "	84%

And for the motor:

Horse power delivered electrically to the terminals....	42·00 and	30·40
Horse power obtainable at the belt...	37·24 "	28·10
Commercial efficiency.........	88·7% "	92%

The method here adopted by the writer in analyzing the experimental results is somewhat different from

that adopted by Messrs. Mather and Platt, but the results arrived at by either method agree fairly well. The commercial efficiency determined according to the makers' way of reckoning is 93·23 per cent. for the tests recorded in the third column, and the discrepancy of 1·7 per cent. is due to the fact that in the calculation which gives the higher efficiency no allowance was made for the increase of friction in the bearings due to the greater pull of the belt where the latter is transmitting the full power, instead of only that portion of the power which is wanted. These results are very instructive. In the first place, they prove that an actual commercial efficiency of 90 per cent. and more can be obtained with a high class dynamo.

They also show that the dynamo, when designed on sound scientific principles, is equally efficient whether used as a generator or motor, a point which has been much discussed of late in the columns of the scientific press. A very important result of the experiments is also that it has been proved to be possible to electrically transmit energy over short distances with a total loss not exceeding 20 per cent.—*The Engineer.*

AN APPARATUS FOR REPRODUCING AT PLEASURE AN INVARIABLE QUANTITY OF ELECTRICITY.

By M. MARCEL DEPREZ.

THE instrument which I have the honor of submitting to the Academy has for its object the easy reproduction, at any time and under any conditions of pressure and temperature, the quantitative unit of electricity which has received the name of the *coulomb.*

It consists of a U-tube, the two limbs of which have been sealed at the lamp and terminate in glass balls, the volume of which is much more considerable than that of the cylindrical portions. One of the balls, as well as the corresponding limb, is completely filled with water, acidulated with phosphoric acid; the second limb contains likewise a little of the same liquid in its lower portion, but in the greater portion of its length it is filled with air at a given pressure, as is also the ball in which it terminates. The limb filled with liqeid has four platinum wires fixed in pairs opposite to each other, one pair in the upper part of the ball and the other in the cylindrical portion, a little below the bottom of the ball.

If an electric current is directed into the two latter, the water is decomposed, and the detonating mixture resulting from this decomposition accumulates in the upper ball, while the liquid driven into the second limb ascends in it, compressing the air in the second ball. If we take care to note the point of departure of the liquid column in the second limb, which is divided into parts of equal capacity, as well as the point at which it stops on suppressing the current, we have all the data necessary for knowing the quantity of electricity expended in producing the detonating gaseous mixture. It is easy to see that if the volume of this mixture, measured by the rise of the liquid in the second limb, is always the same, the quantity of electricity needful for its production will likewise be invariable, and this whatever may be the temperature of the instrument, provided that it is the same in the two limbs, a condition easily realized.

As for the barometric pressure and the hygrometric condition of the air, they have evidently no influence on the result, since the tube is hermetically sealed. Lastly, the liquid being always the same, it will be seen that this instrument allows of the reproduction, whenever required, of a quantity of gas corresponding to an invariable quantity of electricity taken as a standard, the operation consisting simply in reading off a volume, which is always the same, without any correction being required; while with the ordinary voltameter, the corrections for temperature, for pressure, and vapor-tension can by no means be neglected.

In order that the instrument may serve indefinitely, it is necessary to reconstitute the water decomposed at each operation; this is the purpose of the platinum wires situate in the upper part of the balls, where the detonating mixture accumulates. It is sufficient to pass a spark between these wires to induce the combustion of the detonating mixture. The acidulated water again fills the ball, and the instrument is ready for a fresh operation. The apparatus may be made more or less sensitive by filling the second branch, before sealing, with air of a greater or less pressure than that of the atmosphere.

As to the use of this instrument for graduating instruments intended for electric measurements, I think it is useless to enter into details.

This instrument has been submitted to numerous experiments, in which its indications have been compared with those of the ordinary voltameter, with all the corrections required for temperature, atmospheric pressure, etc. These experiments, made with great care by M. Minet, one of the engineers attached to the experiments at Creil, have shown that the indications of the new apparatus are fully trustworthy.

ON A MODIFIED FORM OF WHEATSTONE'S RHEOSTAT.

By SHELFORD BIDWELL, Physical Society.

A WIRE is coiled upon a non-conducting cylinder, as in the ordinary forms of rheostat, one end of the wire being in contact with the brass axle of the cylinder. A screw is cut upon the axle, the pitch being equal to the distance between the consecutive turns of the wire, and this, working in a fixed nut, causes the whole cylinder to travel in the direction of its axis. A fixed spring bears upon the wire at a convenient point, and, by the traveling motion of the cylinder, this point of contact remains fixed in space, and the effect of turning the cylinder is to introduce more or less resistance between the spring and the brass axle. Binding screws on the base of the instrument are in contact with the nut and the bearing spring. Though this arrangement has several obvious advantages over the usual forms, Mr. Bidwell does not recommend it in cases where it is required to introduce a known resistance; but where it is important to adjust a resistance to a nicety or to cause a continuous variation, it is of great use.

Prof. Perry, remarking upon the importance of being able to vary a resistance gradually, described an instrument he had used with advantage. A number of plates of gas-carbon are placed between two parallel copper plates, one of which is fixed and the other adjustable by a screw; by applying pressure by means of the screw, the resistance between the plates can be varied uniformly and regularly from two to ten ohms, beyond which point the increase is very rapid.

MYOPIA.

M. FRANCESQUE SARCEY, the well known French critic, has written a little work* which is well worth the perusal of physicians, by virtue of its charming style and the freshness and force with which he describes the course and the dangers of myopia.

M. Sarcey's book is an autobiography of himself just so far as it relates to his eyes. He begins: "I was born near-sighted, dreadfully near-sighted. Many physicians," he continues, "assert that persons are never born near-sighted, but only become so." We believe that ophthalmologists teach that an hereditary predisposition to myopia is very common indeed, but that congenital myopia is very rare. "However," says M. Sarcey, "science may think what she pleases, but I was born myopic."

The very day on which his infirmity was discovered is indelibly stamped on his memory, and his account of it is quite worth transcribing:

"One day, prompted by the spirit of mischief, I got hold of the big silver spectacles which my father always wore, and clapped them on.

"Fifty years have passed since then, but the sensation I experienced is keen and thrilling to this day. I gave a cry of astonishment and joy. Up to that moment I had seen the leafy dome above me only as a thick green cloth, through which no ray of sunlight ever fell. Now, O wonder and delight! I saw that in this dome there were many little brilliant chinks; that it was made of myriad separate and distinct leaves, through whose interstices the sunshine sifted, imparting to their greenery a thousand tones of light and shade. But what amazed me most, what so enchanted me that I cannot speak of it to this day without emotion, was that I saw suddenly between the leaves, and far, far away beyond them, little glimpses of the bright, blue sky. I clapped my hands in ecstasy, I was mad with astonishment and delight."

Very high myopia like Sarcey's is rare, but moderate degrees of myopia are very common; and myopia, as Sarcey states, is increasing and spreading through Europe like some epidemic disease. Among the ancients myopia appears to have been practically unknown. As evidence of this M. Sarcey refers to the ancient ampitheaters in which thirty thousand spectators sat and viewed the games without a glass. Perhaps, to be sure, the myopes of those days might have learned to stay at home. However, that myopia is increasing there can be no doubt. In fifteen years the proportion of undoubted myopes in the Polytechnic School of France has risen from thirty to fifty per cent., and eighty per cent. of the students have to wear glasses.

M. Sarcey urges his readers, with profound emphasis, to remember that myopia always has a tendency to increase unless numberless precautions are taken, and that all myopic eyes are weak eyes, to be looked after carefully by their possessor. In his own case the result of over-use and misuse of his eyes, especially his attempts to get along without glasses, were that he lost the sight of one eye entirely through detachment of the retina, and that a cataract developed in the other.

The loss of the eye he attributes to the effects of studying when a boy in a badly lighted schoolroom, and he invokes all mothers to examine the schoolrooms. "If they be not fairly flooded with light, take your son home again. To leave him bent for ten years over dimly lighted books is, if he has the least tendency to this trouble, almost certain to lay up myopia for his manhood; if he be already myopic, it is to assure him a blind old age."

Sarcey's description of the development of his cataract and of its removal is vivid and dramatic. The operation was successful, and he now sees distant objects even better than before. The epilogue to his story is: "Remember that all extreme myopia ends almost infallibly in cataract, and that nearly all myopia may become extreme if the eyes are abused."

While Sarcey's views are somewhat tinctured by the bitterness of his personal experience, his warnings are wise and timely, and should be widely read.—*Med. Record.*

* Mind Your Eyes! Good Advice from a Near-sighted Man to his Fellow Sufferers. Translated (with the author's permission) from the French of Francesque Sarcey, by Henry Dickson Bruns, M.D. New Orleans: New Orleans Medical Publishing Co. 1886.

THE TREATMENT OF SEWAGE.

By F. MAXWELL LYTE, F.I.C., F.C.S.

OF all the methods of sewage precipitation the most effective seems to be that by aluminum hydroxide, and the cheapest and most advantageous mode of its formation is undoubtedly that by means of aluminum sulphate and sodium aluminate. The composition of this latter salt would appear to be not as yet fully determined. Roscoe gives $Na_2Al_2O_4 = 165$; Wurtz, $Na_6Al_4O_9 = 392$; and Groves, $Na_6Al_2O_6 = 289$. It is possible that where sodium aluminate is formed by decomposing cryolyte with calcic hydrate, Groves' compound is formed; but otherwise the published analyses of aluminates hardly seem to me to justify the assumption that any aluminates exist of determined composition and of this constitution.

The percentages given for aluminates by Unverdorben, Vauquelin, and others point to the correctness of the formula of Roscoe; but the instructions of Merijot and Debize, in their French translation of Knapp's "Chemical Technology," would rather imply that Wurtz's formula is the right one.

It seems to me probable that really chemically pure aluminates, in which the maximum of base is combined with the alumina, are of Roscoe's composition, but that for practical purposes, on account of the small quantity of silica and other impurities contained in the bauxite from which it is made, it is perhaps preferable to use the proportions indicated by the formula of Wurtz.

When sodium aluminate is mixed with aluminum sulphate, the following reaction takes place, adopting, for reasons above mentioned, the formula of Wurtz:

$$Na_6Al_4O_9 + Al_2(SO_4)_3 18H_2O =$$
$$3Na_2SO_4 + 3Al_2(HO)_6 + 9H_2O.$$

According to this, 6·68 grains of commercial aluminum sulphate containing 13·6 per cent. of alumina, and 5·43 grains of crude sodium aluminate containing 27·3 per cent. of soda and 33·5 of alumina, will produce as much aluminum hydroxide as 20 grains of aluminum sulphate of same composition with its quantum of lime; and in the former case only 3¾ grains of sodic sulphate (a perfectly innocuous salt) pass into solution, whereas in the latter there is dissolved about 10⅛ grains of calcic sulphate per gallon, communicating to the effluent nearly 8 degrees of permanent hardness over and above that it originally possessed.

Suppose, for instance, 1,000,000 gallons of sewage, requiring for purification an addition of (say) 20 grains of commercial sulphate per gallon; this would take 20,000,000 grains = 1 ton 617 lb., and about (say) 800 lb. of lime, costing about £5, whereas the same end would be obtained with 954 lb. of the same sulphate and 776 lb. of crude aluminate, which, putting the first at £1 10s. and the second at £1 11s., makes in all but £3 1s. as against £5 for the old alum process; and further, in collecting the sludge formed by the old process, rather under ¼ of a ton of quicklime has to be added in order to get it to press, rendering it quite worthless as a manure; whereas with the aluminate process, the sludge, being in large part produced from alumina in alkaline combination, does not require the addition of lime. Experiments which have been made in view of valuing the dry sludge from the aluminate and sulphate process have gone to show that it possesses a manurial value of 17s. 6d. a ton for nitrogen and phosphoric acid, but this is probably too low, as the sewage operated upon was of but poor quality, being swollen by rain till its volume was fully four times greater than usual.

Adopting it, however, for the moment, at the present price of soda ash, and that of French bauxite (17s. 6d. a ton f.o.b. Marseilles) for the latter, aluminate of soda may be made at good profit so easily that this treatment with aluminate and sulphate costs half, or nearly so, the price of the old process. In saying this, allowance is made, on the one hand, for the value of the lime to be added to the sulphate, as well as that required for pressing the sludge in the old method, while, on the other hand, the value of the dried sludge from the aluminate and sulphate process is taken at 16s. a ton, in deduction of the cost by this method. Where, then, precipitation is to be employed, whether in conjunction with irrigation or not, the advantage of this process is evident.

Sewage treated in this way, with the quantities above stated, will be found to give an effluent of great purity, reducing to a minimum, if it does not in all cases obviate, the necessity for subsequent irrigation. Of course, less quantities of aluminate and sulphate may be used, but the above are merely adopted as an example, being an equivalent of the 20 grains of sulphate lately used by the A B C Company in some demonstrations they were making with very good results; but whether the aluminum hydroxide formed be intended for use in this or any other process, the above method is by far the best way of forming it. Sodium aluminate is not at present produced on a large scale in England, but its manufacture is easy and advantageous, and doubtless it will not remain long without being made over here.

Besides the above action of the two salts aluminate and sulphate, conjoined in the formation of aluminum hydroxide for the treatment of sewage, there is also the use of aluminate, instead of carbonate of soda or caustic, which presents some advantages in the softening of permanently hard water for industrial purposes. Aluminate of soda, 27 or 28 per cent. Na_2O, at £4 13s. per ton being the equivalent, so far as the Na_2O is concerned, of caustic 60 per cent. Na_2O at £10 a ton; and while it acts just as effectively on the lime salts, producing permanent hardness, reacts far better on the salts of magnesium, to which part of the permanent hardness is often due, producing with them insoluble aluminate of magnesia, provided the carbonic acid be first of all rendered insoluble by an addition of limewater. The difficulty of treating magnesian hardness is well known and recognized, and this takes place in virtue of the reaction shown by the formula:

$$Na_6Al_4O_9 + 3MgSO_4 = Mg_3Al_4O_9 + 3Na_2SO_4.$$

At the present price of soda-ash and bauxite, aluminate of soda should be able to be produced for less than the above price, the manufacture of aluminate involving neither so long an operation nor so much manipulation as caustic, and leaving no residue.

INDIGESTION.

I BELIEVE that we can do a great deal, not only in dyspeptic disorders, but in various chronic diseases, by noting and using this important weapon. It is a well known fact that by a rigid adherence to a dry diet we can accomplish, oftentimes, wonderful results in cases of chronic exudations, especially of a fluid character.

Now, this woman before you had been for some time accustomed to use largely a starchy diet, she consumed very little meat; in time, digestive disorders were developed, she was unable properly to digest this excess of starch, and acid dyspepsia was the result. She in consequence suffered from anæmia, all mucous membranes were pallid, and her nutrition was much impaired.

In this form of indigestion there is a fermentative process established, as the result of which we have the formation of acetic acid and carbonic acid gas. The indigestible article may be fat, when we will have the liberation of fat acids, when, in the eructations, we will have the characteristic disagreeable odor and taste of butyric acid. If the eructations are simply of carbonic acid gas, they will be inodorous, hence we have an easy means of diagnosis between saccharine and fatty indigestion.

Now, in such cases, all remedies will be absolutely useless without a rigid regulation of the diet; we must make a careful study of the diet from the point of view of the various disorders. In this case, as soon as the diet was modified so as to exclude the offending articles, the patient commenced to improve; but as sure as she forgot her caution, and used that food which she

preferred, her bad condition became aggravated. In addition to regulating the diet, I ordered a mixture of carbolic acid, creosote, and bismuth, suspended by glycerine. The glycerine here serves a double purpose, first, by arresting the fermentation (for it is, in itself, a good remedy for flatulency), and, secondly, it serves to hold the other drugs in suspension. This is an excellent combination for stomachal and intestinal fermentation.—*Roberts Bartholow, M.D.*

[Albany Medical Annals.]

THE BACTERIA OF DISEASE.*

By Henry Hun, M.D., Albany, Professor of Diseases of the Nervous System, Albany Medical College.

So much has been said and written during the past few years about bacteria and about their relationship to disease that it must be a matter of interest to every physician to see these little organisms, which are daily becoming of greater and greater importance in pathology. It was my intention, this evening, to have exhibited, under high microscopic powers, a number of different kinds of bacteria, but I find at the last moment that I cannot get a satisfactory light for the microscopes, and therefore we must content ourselves with this engraving below, which is for the most part copied from the specimens that I had intended to exhibit. I regret this the more because I have very few remarks prepared, as I wished rather to devote the evening to a microscopic study of the bacteria.

You all know that in the air we breathe, in the water we drink, and in the earth under us, there are a great number of globular, cylindrical, or filiform bodies which are so minute that they can be seen only under the higher powers of the microscope, and which, when placed in a suitable medium, absorb food, move about, grow larger, reproduce themselves, and give other manifestations of life. These little bodies are, therefore, living organisms, and upon close examination they are found to consist of a central mass of protoplasm inclosed in a membrane or cell wall. They are really small cells, which, however, differ very much in appearance from the cells with which we are familiar as occurring in the human body.

Many of the little cellular bodies have the shape of little rods, and in consequence the whole class have received the name bacteria, from the Greek word *βακτήριον*, "a little rod." The class of bacteria stands very near the border line of the animal and vegetable kingdoms; and although at the present time there is a general unanimity of opinion that they belong to the vegetable kingdom, yet there is still some dispute whether they should be classed among the algæ or fungi.

It has not, as yet, been possible to classify all the different kinds of bacteria, but there are three great groups into which they can be divided according to their form. They are micrococci, bacilli, and spirilla.

Micrococci are spherical or elliptical bodies, which very rarely exceed 2 μ† in diameter. They occur either in separate granules, or in rows like a chain of beads, or in quite large groups embedded in a gelatinous mass, such a group being called a zooglœa, from the Greek *ζῶον*, "animal," *γλοία*, "glue."

Bacilli are rods, varying in length from about 1 to 6 μ and in diameter from 2 μ down to a diameter too small to be measured. They occur either as separate rods or in the form of dense groups, called swarms, or arranged end to end in long chains, which are called leptothrix, from the Greek *λεπτός*, "fine," and *θρίξ*, "hair."

Spirilla are undulating or spiral filaments, varying in length from 4 to 40 μ. They occur either singly or matted together in clusters.

The conditions requisite for the life and development of bacteria are (1) warmth; (2) water; (3) oxygen, either free or in combination; and (4) a sufficient quantity of organic matter to serve as food.

When all these conditions are fulfilled, the bacteria develop with great rapidity until they have exhausted their supply of food; that is, until they have converted the complex organic molecules either into inorganic molecules or into simpler organic molecules, according as there is an abundant or an insufficient supply of oxygen present. When the organic matter is in solution, and when air or oxygen is artificially supplied to this solution in such abundance that there is always free oxygen present, then the bacteria convert the organic matter into carbonic acid, water, and ammonia directly, without the production of any evil-smelling compounds.‡ When, however, the supply of oxygen is limited, as is always the case in nature, then in the decomposition of the organic matter through the agency of bacterial life certain bad-smelling compounds, such as sulphureted hydrogen, etc., are formed, and the process is called putrefaction. From numerous experiments it appears that all putrefaction is directly caused by bacterial life. All the dead organic matter in the world, except what is burned and what is consumed by animals as food, is converted back into inorganic matter by means of putrefaction.

Where it not for the bacteria, the dead organic matter would remain in the world unchanged; and, although organic matters sometimes putrefy sooner than is desired, yet, in general, the bacteria perform a very useful and necessary work in removing the dead organic matter from the world and returning it to the inorganic kingdom. They are the great scavengers of nature.

Fig. 1 represents one of the useful bacteria. It is called the bacillus, and sometimes the hay bacillus, because it is found abundantly on the surface of hay. It is found very commonly in putrefying matters, and is about 2 to 6 μ in length and about 2 μ broad. Under high magnifying powers (700 diameters) the bacillus subtilis appears as a short rod, but under the very highest powers (4,000 diameters), and with suitable illumination, it exhibits at each end flagella, which are constantly lashing backward and forward during the life of the bacillus. Similar flagella exist on all or almost all of the bacilli and spirilla, but not on the micrococci.

The bacteria subtilis, as almost all of the bacteria, can be cultivated artificially either in solutions of organic matter or on a slice of potato or in a solid mixture of gelatin and blood serum. They can be best studied when growing in the solid gelatin, and it is seen that the different kinds of bacteria grow in groups or colonies, which always present the same appearance in the same kind of bacteria, and which differ so greatly in appearance in the different kinds that they can be distinguished from each other by the naked eye.

When their growth and development are carefully observed, it is found that bacteria reproduce themselves in one of two ways—either by fission or by sporification. In the process of fission, the bacterium grows larger, a constriction appears at its middle and becomes so deep that it divides the bacterium into two precisely similar bacteria, which may in turn subdivide. Sometimes before the bacteria separate from each other they each subdivide again, and thus a long chain of bacteria may be formed.

The process of fission is shown in Fig. 2. In the process of sporification, small glistening particles, called spores, appear in the substance of the bacterium, and are set free by the disintegration of the bacterium. They resist injury, such as high temperatures, much more strongly than do the bacteria, and when placed in favorable circumstances they become elongated at one end, grow rapidly, and develop into the adult bacterium. The process of sporification is shown in Fig. 3. "As far as observation goes, young bacilli invariably grow and multiply by division for some time before they produce spores. Continued vegetation without change of soil is usually terminated by the formation of spores, and these spores, as a rule, will not germinate in the unchanged soil where they are produced" (Gradle).

The Bacillus subtilis stands as a representative of the bacteria which are not only harmless, but are extremely useful to the world and to man. Such bacteria surround the body on all sides. They are found in abundance in the mouth, in the intestines, and in all parts of the alimentary tract. The tissues of the human body offer such a resistance to them that they cannot penetrate into the human body proper, and they are never found in the blood or tissues of a healthy person.*

There is, however, another class of bacteria, the members of which, under certain conditions, enter into the body and produce there disturbances which we call disease. There are many diseases each one of which is due solely to the entrance into the body of one or more bacteria of a certain distinct kind. As long as these bacteria are kept out of the human system the corresponding disease will never occur, but whenever these bacteria enter into the body, then the disease may occur. The remaining twelve figures of the engraving represent some of the bacteria which produce disease, or pathogenic bacteria, as they are called. Each of these species of bacteria is distinct from every other, and although they have been cultivated under a great variety of conditions, it has not, as yet, been possible to convert one species of bacteria into another, and no matter through how many generations it has been cultivated, the last generation is as virulent as the first, and produces the same disease when inoculated in animals.

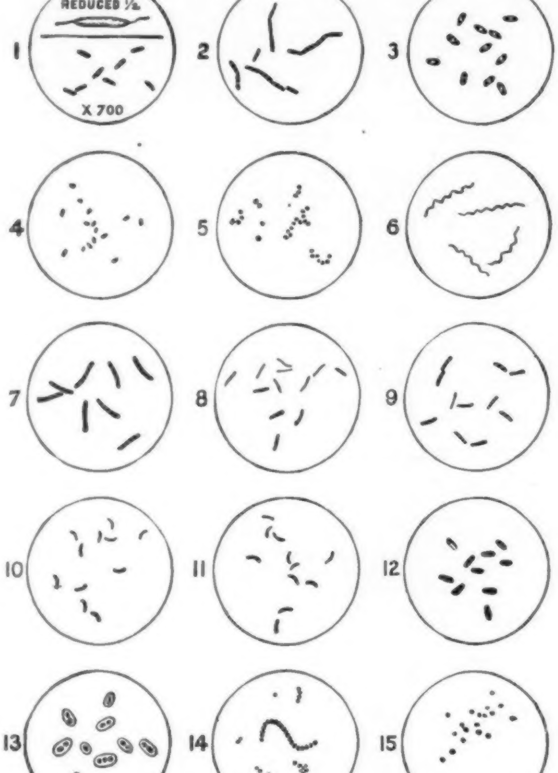
It is possible, however, to render the bacteria less virulent. There are a number of species of bacteria which, when allowed to remain for months in the same culture fluid, suffer a loss of vital power, and when these weakened bacteria are inoculated into animals, they produce the definite specific disease in a mild form. Such inoculations render the animal more or less insusceptible to the disease thereafter, and this is the principle of preventive inoculation for disease.

Figs. 4 and 5 represent the Bacillus septicus and the Micrococcus septicus respectively. The former is about 1·4 μ in length and 0·7 μ in breadth, and the latter is about 0·5 μ in diameter. Either of these bacteria injected under the skin of rabbits, birds, and some other animals will cause death in from sixteen to forty hours, with the symptoms and lesions of septicæmia, and in the blood of the animals thus destroyed are found many bacteria similar to those injected, and these bacteria can be cultivated outside of the body through many generations without losing any of their virulent powers. These two specimens will serve as examples of the bacteria of septicæmia, although there are other bacteria which will cause this disease. The bacterium causing pyæmia is a micrococcus somewhat similar to those represented in Fig. 5.

Fig. 6 represents the spirillum of relapsing fever, called the Spirochæte Obermeyeri, after its discoverer. These spirilla make their appearance in the blood a few hours before the fever, and increase so rapidly in number that during the height of the fever they may even exceed the red blood disks in number, and then disappear as the fever passes off. Although it is probable that the presence of these spirilla in the blood causes the fever, yet it has been impossible to cultivate them outside of the body, so that the experiment of injecting some of a pure culture of them into animals cannot be tried. The spirilla vary from 12 to 43 μ in length and are shaped like a corkscrew, exhibiting from four to ten turns. In Figs. 4, 5, and 6 we have examples of each of the great groups of bacteria—the bacillus, the micrococcus, and the spirillum.

Fig. 7 represents the Bacillus anthracis, the bacillus of anthrax, the disease called splenic fever in cattle and sheep, and in man, malignant pustule. The bacillus has a length of from 3 to 6 μ and a breadth of a little more than 1 μ, and has been more thoroughly studied than any other bacillus of disease. In the bodies of animals this bacillus multiplies only by fission, but when cultivated or growing outside of the body it multiplies by sporification. The bacillus of anthrax introduced into the body causes first a local abscess, then a swelling of the neighboring lymphatic glands, and then the bacilli appear in great numbers in the blood, and death soon results. Like all infectious diseases, anthrax has a period of incubation, which varies in different animals, seeming to depend in part on the size of the animal.

Fig. 8 represents the Bacillus tuberculosis, which are extremely thin rods, varying in length from 2 to 4 μ. These bacilli are found in all tuberculous growths. In young tubercles they are especially abundant in the giant cell. In old tubercles they are found in the periphery, which is the part of most active growth. In the dried or caseous matter no bacilli, but only spores, are present. The Bacillus tuberculosis is present in the expectoration of persons suffering from pulmonary tuberculosis. The Bacilli tuberculosis can be cultivated outside of the body. They increase in number only very slowly, and only when kept at a temperature between 30° and 41° C. When a very few Bacilli tuberculosis are introduced into the aqueous humor of the eye of an animal, small gray miliary tubercles appear on the iris and neighboring parts. These increase in number, coalesce, and lead to a general tuberculous inflammation, which destroys the eye. Later, miliary tubercles appear in the neighboring lymphatic glands, and afterward in the other organs of the body.



BACTERIA MAGNIFIED ABOUT 700 DIAMETERS.

1. Bacillus Subtilis. 2. Multiplication by Fission. 3. Reproduction by Spores. 4. Bacillus Septicus (rabbit). 5. Micrococcus Septicus (rabbit). 6. Spirillum of Relapsing Fever (Spirochæte Obermeyeri). 7. Bacillus of Anthrax. 8. Bacillus of Tuberculosis. 9. Bacillus of Leprosy. 10. Bacillus of Asiatic Cholera. 11. Bacillus of Cholera Nostras (Finkler and Pryor). 12. Bacillus of Typhoid Fever. 13. Micrococcus of Pneumonia. 14. Micrococcus of Erysipelas. 15. Micrococcus of Diphtheria.

* Read before the Medical Society of the County of Albany, February 10, 1886.

† μ = micromillimeter = one-thousandth of a millimeter.

‡ Hoppe-Seyler, Zeitschrift for Physiol. Chemie, viii., s. 214.

* Virch. Archiv., vol. 95, p. 401.

Fig. 9 represents the bacillus of leprosy, which is a little thicker and longer than the Bacillus tuberculosis. This bacillus is always found in the new growths of leprosy, but it has not as yet been possible to inoculate it in animals.

Fig. 10 represents the bacillus of Asiatic cholera (the comma bacillus of Koch), which is found in the dejections, in the contents of the intestines, and in the intestinal glands in cases of cholera. This bacillus has the form of a written comma, and is about 2 μ long and 0·5 μ thick. It is destroyed by acids, and only thrives in alkaline solutions. It can readily be cultivated outside of the body. The normal acidity of the gastric juice kills it; and in order to successfully inoculate it in animals, it must be injected into the intestines, where it will meet with an alkaline fluid. When thus injected, it speedily causes death, with all the symptoms and lesions of cholera. The comma bacillus of Koch has been the subject of much dispute, and many observers have claimed that they have found precisely similar bacilli of a more or less harmless nature. One by one, however, these various bacilli have been shown to bear only a very superficial resemblance to the true comma bacillus, and now only one bacillus remains which bears any close resemblance to the comma bacillus.

Fig. 11 represents the bacillus which is called the comma bacillus of Finkler and Pryor, and which is found in the contents of the intestines and in the recent dejections of cases of cholera morbus. These bacilli are a little thicker than the comma bacilli of Koch, and differ from these latter also in their manner of development and in the effects produced when they are injected into the intestines of animals.

Fig. 12 represents the bacillus of typhoid fever. It is shorter and much thicker than the Bacillus tuberculosis, and is rounded at its extremities. It has been found in the intestinal follicles, mesenteric glands, and spleen in about half of the cases of typhoid fever in which it has been sought. It can be cultivated, but it has not as yet been successfully inoculated in animals, so that its causal connection with typhoid fever has not been satisfactorily established.

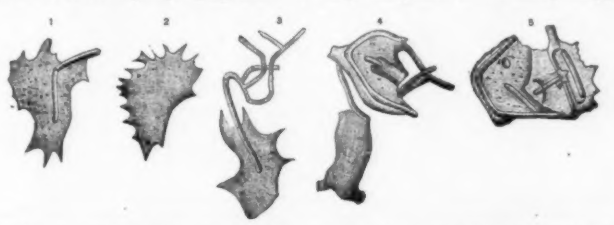
Fig. 13 represents the micrococcus of pneumonia, or the micrococcus of Friedlaender. This micrococcus is surrounded by a gelatinous capsule, which usually incloses two or three micrococci, two being thus inclosed with especial frequency. These micrococci occur in the exudation in the alveoli, especially near the walls of the alveoli, and in the expectoration. They can be cultivated outside of the body, and when inoculated in animals, pneumonia is produced.

Fig. 14 represents the micrococcus of erysipelas, which has a tendency to form curved lines like a chain of beads. It can be cultivated outside of the body, and when inoculated, erysipelas results. It has, indeed, been inoculated in man for therapeutic purposes, in the hope of arresting the growth of tumors, etc. From such inoculations it has been learned that an attack of erysipelas protects the person for a variable period from another attack. The immunity usually lasts for three months.

Fig. 15 represents a micrococcus which is always found in diphtheritic membranes, although up to the present time it has not been possible to satisfactorily isolate it.

These figures do not exhaust all the varieties of the bacteria of disease which are known. The micrococcus of gonorrhœa and the bacillus of syphilis, of xerosis conjunctivæ, of glanders, have all been isolated, and in all probability cause the diseases from which they derive their names, while many other bacteria have been discovered which probably, although not certainly, cause certain diseases, such as trachoma, rhinoscleroma, small-pox, whooping-cough, etc.

Whenever any of these pathogenic bacteria enter into the body, they absorb their food and oxygen from the tissues, and grow and multiply. If this growth and multiplication were unchecked, they would consume all the tissues, and soon cause the death of the animal. The animal system, however, possesses the power of acting upon the bacteria and destroying them more or less completely, and as a result of this action a complex of symptoms is produced, which is called disease. The essence of many forms of disease consists in a struggle for existence between the bacteria and the animal tissues. In the case of the simplest animals, this struggle can be observed under the microscope. The simplest form of animal life is the amœba, which is altogether similar to the lymph corpuscles of animals; and when a little lymph from a frog is placed together with a few bacilli of anthrax on a warm stage, and observed under the microscope, some very noteworthy phenomena take place, which have been described by Prof. Metschnikoff, of Odessa,* and which are in part represented in the accompanying figures.



LYMPH CELLS DESTROYING BACTERIA (METSCHNIKOFF).

Fig. 1 shows a white corpuscle of the frog's lymph which is taking a bacillus into its interior. Fig. 2 shows the same corpuscle ten minutes later, when it has not only taken the bacillus into its interior, but has caused its disappearance. Fig. 3 shows the same corpuscle a quarter of an hour later, trying to take a whole group of bacilli into its interior. Fig. 4 shows the same corpuscle a quarter of an hour later, when another corpuscle has come to its aid. Fig. 5 shows the same two corpuscles ten minutes later, when they have taken the whole group of bacilli into their interior. From these figures it appears that the lymph corpuscles possess not only the power of taking the bacteria into their interior, but also of causing them to disappear (Fig. 2). Other figures of Metschnikoff show how this disappearance or destruction of the bacteria within the corpuscle is accomplished—the bacilli either break up into small fragments or granules or else their outlines become more and more indistinct till they disappear. In this way the lymph cells destroy the bacilli. In other cases the bacilli destroy the lymph cell, causing it to burst and disappear. By further researches Prof. Metschnikoff finds that the bacilli are not destroyed by the fluids in the tissues, but only by the white corpuscles; and it appears that when a white corpuscle has eaten one or more bacilli, it thereby becomes changed, so that thereafter it is able to destroy the bacilli more easily. Finally, Metschnikoff finds that at certain temperatures the white corpuscles act more strongly and the bacilli less strongly, so that the latter are destroyed by the former, while at other temperatures the reverse is the case. From these experiments it would appear that there is a mutual antagonism between the lymph cells, or white blood corpuscles, on the one hand and the bacteria on the other, and that when the latter enter into the human body, the former tend to destroy them.

Another set of experiments, by Strauss,* definitely prove, what has long been a matter of doubt, that chemical irritants, such as turpentine, croton oil, etc., cannot produce suppuration without the presence of bacteria. In the light of these two sets of experiments (first, that without the presence of bacteria pus is never formed, and, second, that the pus cells, or white blood corpuscles, can destroy the bacteria), we are able to understand a little more clearly the meaning of some of the phenomena of septicæmia in the broadest sense of the word.

When the fresh surface of a wound is free from all septic bacteria, the wound heals quickly without suppuration or constitutional disturbance. When, on the other hand, septic bacteria are present on the surface of a wound, then the wound does not heal quickly, and suppuration and other symptoms of disease appear. Pus is poured out on the surfaces of the wound, and prevents their uniting, and although this formation delays the healing of the wound, yet it is of great value in the preservation of the well-being and the life of the individual, and is really curative in its nature. It is the only barrier which can be thrown out against the general infection of the body. The pus cells are the only elements which can destroy the bacteria. If these latter are few in number, they are quickly destroyed by the cells, little or no destruction or decomposition of tissue is produced, the flow of pus ceases, and the wound heals. If, on the other hand, the bacteria are in great abundance, they grow and multiply, and not only destroy many of the cells and the tissues, but in so doing produce decomposition and putrefaction, so that the pus and discharge from the wound has a very unpleasant odor. In such a case many of the bacteria pass beyond the barrier of cells poured out to destroy them, and, entering the lymph channels, reach the nearest lymphatic glands. Here the same process is repeated. There is a curative hyperplasia of the glands; that is, there is within the glands an increase in the number of lymph cells, which may destroy the bacteria, so that with the hyperplasia of the lymph glands the disease may terminate. In severer cases, however, the bacteria are so numerous or so virulent that they pass beyond the lymph glands and enter the general circulation. Then appears a remarkable sympton which is called fever, and which consists essentially in an increase in the heat of the body.

The fever which is produced by the entrance of bacteria into the blood causes much discomfort, and is at times dangerous to life, and yet in all probability it fulfills a most useful purpose.

The Bacillus anthracis has its greatest activity and produces spores only between the temperatures of 64½° and 107½° F. Pasteur claims that anthrax cannot be inoculated in a fowl, because its normal temperature (106½°) is too high for the life and growth of the bacillus; but when the normal temperature of the fowl is lowered by immersing its legs in cold water, then it can be inoculated with the bacillus successfully. The Bacillus tuberculosis can be cultivated only between the temperatures of 86° and 106° F. The spirilla of relapsing fever are rendered motionless in a very few hours by a temperature of 104° F., and it is probable that a temperature of 103° to 106° F. will weaken all the bacteria of disease so greatly that they are readily destroyed by the white corpuscles of the blood, while at the normal temperature of the body the bacteria might destroy the white corpuscles. It seems, therefore, altogether probable that the fever of septicæmia, as well as every other form of fever, is curative in its nature, in the same way that the suppuration and the hyperplasia of the lymph glands are curative.

In cases of septic poisoning the system reacts against the pathogenic bacteria by suppuration, hyperplasia of the lymphatic glands, and fever. These are the three great symptoms of septic poisoning, and they are all curative in their nature. The treatment of any case, therefore, should be directed, not against the symptoms, but should be calculated to weaken the vitality of the bacteria and increase that of the white corpuscles.

In a manner quite similar to that described for septicæmia, almost all the other pathogenic bacteria, when introduced into the system, produce at first a local inflammation, then a hyperplasia of the neighboring lymphatic glands, and finally fever. Each of the symptoms causes discomfort, and each may become so excessive as to destroy the life of the patient; yet in their essential nature they are curative, and our therapeutic efforts should be directed, if possible, against the cause of the disease and toward maintaining the patient, while an attempt should be made to modify the symptoms of disease only when they are manifestly excessive.

In the light of our present knowledge, it seems to me that we can hardly attach too much importance to the following sentence, with which, in the middle of the seventeenth century, Sydenham commenced his medical essays: "A disease, in my opinion, how prejudicial soever its causes may be to the body, is no more than a vigorous effort of nature to throw off the morbific matter, and thus recover the patient."

* Virchow's Archiv., vol. xcvii., p. 502.

* Revue de Chirurgie, No. 2; Bulletins de la Societe de Biologie, 1883, p. 651.

NEW METHOD OF PASSING STRICTURE OF URETHRA.

DR. WILLIS P. KING, of Sedalia, Mo., in the St. Louis *Courier of Medicine*, describes an extemporaneous method of enabling the physician to pass a urethral sound or catheter in cases of urethral obstruction or stricture, which is worth remembering. So far as Dr. King knows, the method is entirely original with him, and he has successfully adopted it in the only two cases in which he had occasion to try it. The method, briefly stated, consists in passing a small flexible catheter into the urethra down to the seat of stricture, or obstruction, until it will go no further. Then affix the nozzle of a suitable syringe, filled with water, to that end of the catheter which is outside of the penis; and after sufficiently compressing the head of the penis with the thumb and finger, to prevent regurgitation of the fluid, inject the water into the urethra. This injection will sufficiently dilate the stricture to allow the catheter, with slight pressure, to pass through it into the bladder. In the want of a syringe, the mouth may be filled with water and similarly squirted through the catheter with the same effect. After the catheter has thus made its way into the bladder, it may be withdrawn, and a proper sized catheter immediately introduced.

HYGIENE OF OLD AGE.

AT the recent Sanitary Convention, Philadelphia, a paper was read on this subject by Dr. H. C. Wood, of Philadelphia.

Leaving out of consideration deaths from accidents, fevers, lightning strokes, and other more or less preventable causes, the man who is so built that he is equally strong in all his parts lives out his appointed days. Excessive strength in one part is a veritable source of danger. The athlete perishes because his over-developed muscular system perpetually strains and finally wears out the heart or lung, which was originally constructed for a muscular apparatus of half the power of that which is artificially built up. The large proportion of mankind die early on account of some local weakness. Human age is not to be accounted by years. In some individuals the general tissues are older at fifty than in others at one hundred. Many of the cases of so-called neurasthenia and nerve exhaustion in men and women, with sudden or gradual breakdown at forty or fifty, apparently from overwork, are really cases of premature old age, and they are to be treated in precisely the same manner. A large proportion of early deaths are the result of some feeble organ being originally endowed with a longevity less than the rest of the organism.

The man who enjoys fair health at seventy-five has probably been built upon the principle of the famous "One Horse Shay," described by our inimitable Holmes, and he should be treated as a wise man would treat such a venerable instrument of progression. The principle involved in such cases is that of protection, and especially protection from strain of any feeble part. Exposure to inclement weather, especially to high winds, is injurious, by throwing a great strain upon the heart, and this may result in sudden death, or, if it does not, may lead to a fatal pneumonia. Emotional disturbance, as the sudden receipt of good news, may have a like result. Medicines that perturbate and measures that bring relief by inducing a violent local action are to be avoided; at the same time incipient disorders should, if possible, be arrested at once.

In regard to details, every old person should go over, with a wise counselor, his whole method of living and personal habits. The first question is in regard to food. The lost teeth should be replaced by artificial ones to facilitate chewing; but even then the food should be soft, easily comminuted, and readily digested. The food should not be of a stimulating character. Many old people are injured by too much nitrogenous food. Milk and breadstuffs cooked with milk should form a large part of the diet of the aged individual. Excessive quantities of food should be avoided. Many old people are more comfortable, enjoy better health, and probably live longer for the use of wine. The habitual use of wine in youth or in middle age, in vigorous health, is, I think, a harm rather than a good. But when the powers of life are failing, when digestion is weak, and the whole system feeble, one or two glasses of generous wine at dinner aids digestion, and quiets for the time being nervous irritation. The danger of the formation of any evil habits when a man is past seventy is very slight, and no conscientious physician need hesitate in recommending the daily use of alcoholic beverages to his patient.

In many cases of death the final result is due to cold and the failure on the part of the body to keep itself warm. In the old, the heat making functions are exceedingly low, and few old people are comfortable in a room the temperature of which is lower than 80°, and abundance of warm, but light, clothing should be provided. There is no ordinary garment which compares in heat preserving power with the buckskin jacket, and every man beyond the age of seventy should provide himself with such a garment. At first it should be worn only out of doors, but later, it should form part of the habitual underclothing. If worn as an under jacket, it should be perforated; when there is a tendency to abdominal weakness or to pendulous abdominal walls, a flannel bandage should be worn. The mechanical effects of an abdominal bandage in affording support to the abdominal organs and vessels are well known.

Dr. Laurence Turnbull, of Philadelphia, in discussing the paper, referred to some of the causes of death in the aged. Too much exercise was one of these. When

an old person walking up an elevation, or against the wind, feels an oppression in his chest or a pain in his back, he should stop Exposure to night air is bad for the aged, and often leads to bronchial catarrh and pneumonia; a night cap should be worn in bed. Flannel underwear should also be worn; exposure to the sun should be avoided in summer.

He agreed with the author of the paper in all points, with the exception of his recommendation of wine. If a stimulant is required at all, it should consist of alcohol and water in a definite mixture, rather than of wine, and withdrawn when the patient is able to take a sufficient quantity of stimulating food. Old age is no protection to the temptations incident to our physical natures; rather does it weaken the resistance to these temptations, and more than one medical man can recall painful instances where a youth of probity and a middle age of honor has been darkened by an intemperate old age. Mr. Wickfield, in "David Copperfield," is by no means an unreal character in life. —*Med. Record.*

REPTILIAN LIFE IN INDIA.

One of the American magazines which came to Panhala not long ago contained a harrowing account of a row which took place in the neighborhood of alligators and moccasin snakes. Alarming as such an incident must have been, it was really no more than a mere trifle compared to the experiences which people who live in this part of tropical India have to undergo almost daily.

In one governmental district in India, about 23,000 persons are reported as dying yearly from the bite of poisonous reptiles or the attack of savage beasts. Considering the perils with which one is beset here in Panhala, the wonder is that the number of deaths is not very much larger. Leopards and tigers are shot in the country around here, and at times they prowl around the dwellings of the people in the night, and sometimes try to effect an entrance. Poisonous reptiles are so numerous and so quick to improve every opportunity to enter the houses that no one can relax his watchfulness for a moment without being placed in danger of his life. For instance, no one would think of getting into bed without first looking for what may be and frequently is cozily ensconced between the cool sheets. No one would spring out of bed in the night without first striking a match, even though he be so brave that he pooh-poohs at the idea of keeping a night lamp burning. Even the bath is not a luxury entirely devoid of danger from one or more of these poisonous creatures. To-day a snake is found in one's shoe; to-morrow in the bath sponge there is a scorpion. The next day a centipede is found under the flower-stand; and the next there is a scorpion in the novel one has been reading, or a snake on the shelf or hidden away in one's napkin at dinner.

Not long since, a friend from the coast related while visiting here a recent experience which is really not uncommon in this part of the world. One evening, leaving the lamp in his dressing room, he stepped into an adjoining room in the dark. Noticing the peculiar odor, so like that of raw potatoes, which often indicates the presence of a snake, he called to his wife to bring a cane and a lamp. Knowing well what such a call means, she lost no time in providing the needed stick and light. There on the step over which he had just entered the room lay an immense cobra, enjoying the coolness of the place after a hot day on the scorching plains. Mr. I. had stepped directly over his majesty; and had it not been for the unmistakable odor which betrayed the snake, he might not have lived to tell the tale. It is a fortunate fact that the cobra can readily be killed with a cane or club.

One Sunday afternoon while walking in his plantain garden, deeply engaged in thought, a gentleman here was not a little astonished to have a large snake spring from between his feet and glide into one of the small buildings attached to the place. It had been engaged in swallowing a toad, and seemed as startled as the sahib himself. The latter, calling for help, instituted a chase. It took some courage to enter this small room, as it was not known to what species the reptile belonged. Armed with a new American ax and a bamboo cane, the hunt progressed for a few moments, during which the snake sprang several times seemingly its full length into the air, making futile attempts to escape. The ax came off conqueror, and it was found to be a dhaman, measuring seven feet seven inches in length. This kind of snake has no fangs, belongs to the coluber order, and "kills with its tail," so the natives say. It is known to be destructive to cattle, in the nostrils of which it insinuates its tail, and then draws it forth with violent abrasion.

It is no strange sight to find in the morning a cast-off skin of some snake on the lattice which protects one's window, or twisted about over a bit of terrace wall or on one's pet rockery, which, by the bye, is a most dangerous form of a flower garden, as it affords shelter for snakes lizards, centipedes, and scorpions innumerable. A few days ago I found one of these sloughs of a cobra, seven feet in length, but I presume it was longer for being empty, for while it is common to hear of a five foot cobra, one seldom hears of one as long as six feet.

Not many days have passed since the following occurred: One stormy evening a door being heard to slam, one of our family went in the dark to close it. This time, not from any odor, but from a feeling of instinct taught by experience, our friend stopped with one foot raised, and called for a light. The light was brought (for we do not have gas), and revealed a green, triangular headed viper, just ready to strike with its ivory white fangs, which at the time seemed immensely long. The reptile was struck down at once and held firmly with one stick until a second one could be brought. Meanwhile the deadly, but still pretty, creature was writhing about the cane which held it, biting and tearing its own flesh. The strange fact which Dr. Weir Mitchell made known to the world in 1868, that a poisonous "snake cannot poison itself," is no less strange because true

One evening, sending a servant to hunt for a pair of missing scissors, we were not much surprised to have him soon run in breathlessly, saying, "Come, sahib! A snake, a snake!" On investigation we found that in looking in a corner for the missing article, instead of seeing the looked for scissors he saw the bright bead-like eyes of a snake called ratra (night) looking into his. It is a pretty snake, being of a seal brown color on the back, crossed by crescent bands of white, while the belly is a beautiful red. The name may not seem definite, but is given to it by the natives, who say it is found at night, hence the name. It was only the next day that the baby of the house was found amusing itself by rolling a jack fruit back and forth over a ratra which was close to its feet. These are possessed of fangs, so of course are not harmless. A few nights later, just as I was about to step into bed, something told me not to move my raised foot, so carefully reaching for the lamp and looking under my foot, there I beheld a great scorpion, which after death measured five inches as one would lie or stand at ease if alive.

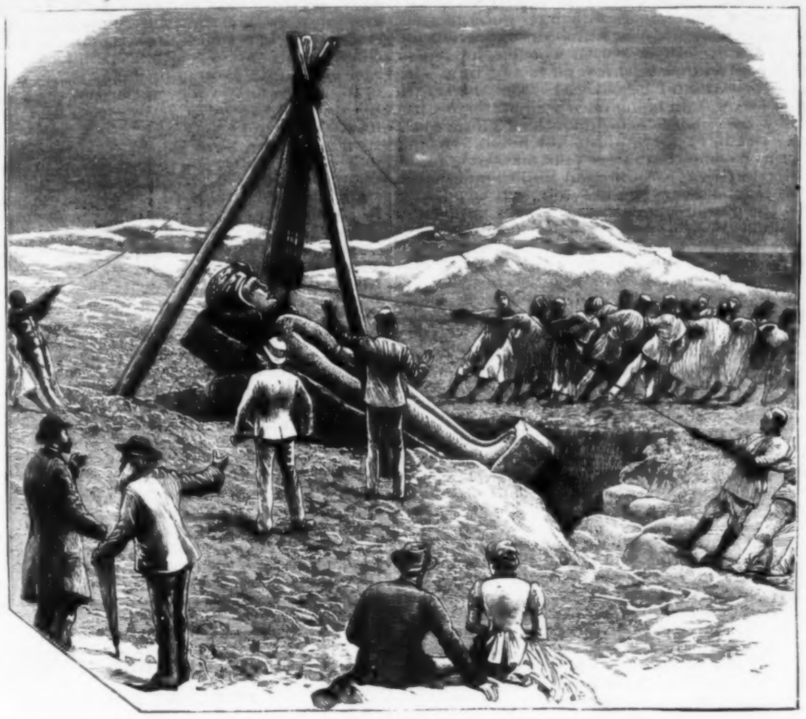
One night after supper, as the butler removed a child's tray, there was disclosed to view a wicked little scorpion underneath which might have inflicted a painful wound had the child put his fingers under the edge. That very evening as the family were about to have family worship, another scorpion, probably a twin brother, came running rapidly toward a pair of tender little bare feet. Whether eating, sleeping, or praying, there is danger from these creatures. In the cool, shadowy depths of baby's sponge, the wicked, though small, scorpion finds a comfortable retreat.

A few months ago I found a grown scorpion and put it into an empty bottle. It was forgotten for a few days. When remembered and examined, alas! where there had been only one there were twenty-eight! But this rapidity of increase is offset by its bitter enmity toward all others of its own kind. They seem, too, to be devoid of natural affection, the offspring destroying their own mother. The centipede is not an infrequent visitor. About the size of a man's finger, it is composed of alternate links of brown and white, numbering in all eighteen or twenty links, making an entire length of seven inches. Each link is furnished with a pair of red legs, and the round head and feelers too are of the same bright color. The bite is usually fatal, unless remedies are applied at once. Surely, the promises in the ninety-first psalm are fulfilled to those in this land who have made the Lord their habitation.—*N. Y. Tribune.*

STATUE OF RAMSES II., THE PHARAOH OF THE TIME OF MOSES.

UNEARTHING A STATUE OF RAMSES II. AT ABOUKIR.

"This statue was discovered," writes Middlemass Bey, a lieutenant in the Royal Navy, Inspector in Chief of Egyptian Coastguard, "on the occasion of my having ordered some of my men to dig for stones to repair a fort near Aboukir, over the supposed ruins of the ancient town of Canopus. They reported having unearthed a carved granite pillar. I at once excavated it, and found it to be a statue of red granite, about ten and one-half feet high. On January 1, last, Mr. Wilbour, the well-known antiquary and Egyptologist, at the request of M. Maspero, Director of Egyptian Museums, came with me to decipher the hiero-



RAISING THE STATUE.

glyphics, and pronounced the large figure to represent Ramses II. (the Pharaoh in whose reign Moses was born), and the smaller figure to be that of his son (who was drowned while pursuing the Israelites across the Red Sea). It is about 3,400 years old, and is in excellent preservation, and lies about three-quarters of a mile from the shore. With some gear from the fort I raised the statue on end. There are hieroglyphics down three sides and on the heart of the figure. The back and the front and the left side are covered with hieroglyphics. As the ground has never been properly excavated, I hope to be lucky enough to find some more similar objects in the neighborhood. A statue very much resembling this one is one of the sights at Sakhara, near Cairo. The stone is Sinite granite, from Assouan. A picnic party recently held here unearthed a considerable number of old Greek coins. Near the spot where the statue stands are some gigantic granite pillars, said to be part of the Temple of Serapis, for which this spot was once famous. In those days the Canoptic mouth of the Nile flowed out by Aboukir."

NEW COLOSSAL STATUE OF RAMSES II.

THE Temple of Luxor may be divided into two portions; the older temple was built by Amunoph III., the later by Ramses II. Together they form one of the most imposing monuments of Upper Egypt. Five years ago the Ramses Temple was hidden under a mass of houses and hovels, which had been built against the columns and walls of the ancient edifice, and to such an extent had the soil accumulated that the pavement of the temple was fifty feet below the ground floor of the modern houses.

In 1881 it was determined to rescue what remained of the temple, and to clear away the earth that filled its courts and colonnades. The first step was the removal of the native village, a proceeding more easily decreed than executed. Each individual was offered a piece of ground and a sum of money equal to the value of his house, an equitable proposal which was gladly accepted by the villagers; but, having secured the cash, they plainly and positively declined to abandon the homes of their infancy. A sharp struggle ensued between the Egyptian Government and M. Maspero on one side and the inhabitants of Aboo 'l Haggag on the other; but eventually the villagers were signally routed, and the last house will be pulled down in a month or two. M. Maspero's difficulties were not terminated with the acquisition of the ground. The men of Aboo 'l Haggag flatly refused to work at the excavations; however, they altered their tone when it was seen that laborers were coming in from Karnac and other neighboring villages, and then the removal of the earth commenced in earnest.

Last year's work was mainly directed toward clearing the Temple of Amunoph III., and the scantuary is now entirely free from rubbish. Some of the houses were removed from the Ramses Temple, revealing the upper portion of a small portico, with four colossal heads between the columns. It was here that operations were commenced last spring, and very soon the excavators came to the head of a colossal statue in granite of Ramses II. Unlike the other heads, it was in a perfect state of preservation; and as the earth was removed the entire standing figure was found to be intact, save that the head dress, the Crown of Upper and Lower Egypt, had been thrown down and lay in the earth beside the statue. The effigies of Ramses II. that have been discovered in Egypt are numerous, but probably none equal the Luxor statue in artistic excellence—at least such is the impression produced by the work in its present state, before the dirt and mud have been removed from the polished granite surface. It would besides be only natural to infer that especial pains would be taken in elaborating the portrait of the great king for the temple erected by himself, in the immediate vicinity of his palace at his favorite residence at Luxor.

The statue is nude, except for the plaited apron-like drapery round his loins; a dagger with an eagle's head is held in the girdle, the cartouch of Ramses II. is seen in three places, twice on the front of the statue, and a third time in an object held in the left hand. A column of hieroglyphic inscription runs down the back of the figure.

Our illustration shows the statue *in situ*, as it appeared a few days after its discovery, while the earth was being cleared away from the feet. The pedestal was not then uncovered. The height of the statue is over sixteen feet. It is to be removed to the Museum at Boulak, as tourists have an inveterate habit of scribbling and carving their names upon the ancient monuments of Egypt, and in this manner have irretrievably damaged numerous invaluable statues and bass-reliefs. Our engraving is from a sketch by Mr. Henry Wallis. —*The Graphic.*

HYACINTHS IN HOLLAND.*

BULBS or flower roots have for over two hundred and fifty years been grown and cultivated in the vicinity of Haarlem, and their cultivation has gradually increased in importance until it has reached its present position. Among the admirers and lovers of plants and flowers, bulbous plants have always found many ardent protectors. No doubt the advance which civilization has made in nearly all quarters of the world has aided greatly to extend the cultivation of flower roots and increase the demand, even in countries where fifty years ago there was not a single bulb, and where hyacinths and tulips were nearly unknown. An advantage which bulbs have over plants in general is, that bulbs have nearly all a yearly period of rest, when they can, without much fear of injury, be packed and be exported to the most distant places. An advantage worth mentioning is that after they have done blooming and have grown to their full maturity they require only to be placed in a dry locality, and for a considerable time require no labor or attention. A further important advantage of such bulbs as hyacinths, tulips, etc., is that by artificial treatment they can be brought to grow and bring out their bloom several months earlier than they would do when kept out of doors and left to their natural development, which for winter bloom makes them unequaled by any other family among living plants. The so-much-beloved hyacinth is not only one of the most esteemed among bulbs, but also one of the most beautiful, although at the same time the most difficult in cultivation and the most expensive to bring to perfection.

The hyacinth is a native of the Levant, and was first introduced into England in the year 1596; but it was known to Dioscorides, who wrote about the time of Vespasian. Gerard in his "Herbal," published at the close of the sixteenth century, enumerates four varieties—the single and double blue, the purple, and the violet; and Parkinson in 1629 speaks of eight different

* A paper by Mr. Polman Mooy, read before the Horticultural Club, March 23.—*The Garden.*

ANOTHER RECENTLY DISCOVERED STATUE OF RAMSES II. AT LUXOR.

varieties. He tells us that "some are pure white, others are nearly white with a bluish shade, especially at the rims and bottoms of the flowers. Others, again, are of a very faint blush; some are deep purple, nearly violet, others purple tending to redness, and some paler purple. Some, again, are of a fair blue, others more watchet, and some very pale blue. After the flowers are over, the plants bear round black shining seeds, from which, after sowing and protecting, new varieties can be obtained." During the 250 years that have elapsed since the above was published there has been a steady improvement in the size, form, and color of the flowers of this plant. From the eight varieties of 1629 more than 4,000 varieties have been produced, of which, however, the greater number has become extinct. Many have been thrown out to make room for the latest improved sorts, among which about 200 varieties only are at present in extensive commerce.

The varieties of color vary from the purest white to the deepest shades of scarlet, purple, black, yellow, and violet.

Hyacinths, like other plants, have undergone great changes, and, as a matter of course, these have considerably influenced the varieties which have been propagated and grown. From sixty to seventy years ago there was a taste in general for the double flowering varieties and more particularly for flowers with dark or in other colors striking eyes or centers, and I remember the time when a few beds sold by public auction realized very high prices indeed, but the varieties thus sold have fallen quite out of cultivation. These double varieties mostly produce very small bulbs, a fact which contributed very much to their being neglected and to their loss of position in public estimation; raisers looked out for the largest sized bulbs, basing their recommendation upon the general, but erroneous, belief that naturally the largest bulbs must also produce the largest flower spikes. The small-bulb producing varieties, however beautiful they might be, could not therefore at that time find buyers; growers were then compelled to meet the alteration in public taste as quickly as possible, and as this alteration came rather suddenly and much quicker than the slow growth and propagation of the desired sorts could meet, prices at that time rose wonderfully high. In this run after large bulbs many sorts with very inferior flowers were brought out in quantity; but although these large bulbs did increase the general trade, and so far satisfied the bulb sellers abroad, still they did not give universal satisfaction, and better flowers were looked for. After large sized bulbs large spikes of flowers became in demand, and also single varieties, which were found capable of giving greater satisfaction than doubles; but when we compare the large spikes of the present day with the sorts which we had sixty years ago we ought to be well satisfied with the progress we have been able to make. Although the double varieties have at present become much neglected, mostly because of their small sized bulbs, there are some few double sorts which have pretty well maintained their position in public estimation, but their number is small compared with the single ones in cultivation. Among the best double sorts I may mention Lord Wellington and Grootvorst, rose; Prince of Waterloo, La Tour d'Auvergne, and Florence Nightingale, white; Louis Philippe and Garrick, dark blue; Blocksberg and Rembrandt, light blue. Of the double yellow flowers Goethe is about the best, but most in this color are rather small in the spike. Of dark reds among the double flowers there are but very few varieties; of these Louis Napoleon and Waterloo are about the best, but the latter sort is not so fully double as could be wished. Among single varieties we at present possess the greatest variety of colors, and among them we now have large and handsome flowers. The best are Garibaldi, Pellissier, Scarlet Light, brilliant scarlet; Fiancée Royale, Gertrude, Koh-i-noor, Prima Donna, Von Schiller, red; Carlyle, Chas. Dickens, Dr. Livingstone, Gigantea, Macaulay, rose; La Grandesse, Alba Superbissima, Crown Princess, Madam Van der Hoop, pure white; Grandeur a Merveille, Baroness Van Tuyll, Mammoth, Seraphine, blush white; General Havelock, Baron Von Humboldt, Masterpiece, Mimosa, William I., black blue; Baron Van Tuyll, Chas. Dickens, King of the Blues, Bleu Mourant, dark blue; Blondin, Czar Peter, Grand Maitre, Leonidas, Grand Lilas, Lord Raglan, light blue; L'Honneur d'Overveen, Sir Henry Havelock, Chas. Dickens, Haydn, violet; Ida, King of the Yellows, La Citroniere, Obelisk, Anna Carolina, pure yellow; Beauty of Waltham, Clio, Lamplighter, Lord Palmerston, Argus, flowers with striking eyes or centers. All varieties have been obtained from seed selected out of thousands of seedlings, the result of artificial crossings, an occupation of very long duration, as a little bulb grown from seed requires six or seven years before it is of sufficient size to produce good flowers; and when we consider that this bulb if found worthy to be grown on requires twelve to fifteen or twenty years' careful artificial propagation before a moderate stock can be had, it need not create astonishment when at times new varieties have realized large sums of money. New varieties in almost every shade of color have been saved from year to year, showing improvements in size of spike, of bulb, and of bells; but it may be worth remarking that in all the different colors we have obtained improvement in size of bells with the exception of the bright scarlet colored sorts, which until now have always turned out to have small, narrow bells.

If we could obtain a hyacinth flower of a bright scarlet color like Queen of the Hyacinths or Garibaldi, with bells as large as La Grandesse or Cloche Magnifique, what a grand improvement it would be, and we do not despair of yet obtaining this treasure. Between the time when double hyacinths were most esteemed and that when single varieties came into favor, a period of perhaps ten years, the always increasing demand was greater than could be satisfied, and consequently the prices of hyacinths grew higher every year, and at that time hyacinth growing was rather profitable. This induced numbers in the neighborhood of Haarlem to set about growing hyacinths, which many have done with more or less success. At that time land was worth only half the price that it is at present, and the most easy-growing hyacinths were then artificially propagated to such a large extent that the stock overgrew the demand, and forced the market price of such sorts down to such a low ebb, that during the last two years thousands of hyacinths have been exported at prices below the actual cost of production, causing great losses to the growers.

For forcing, the bulbs should be potted about the middle or end of September, in 5 inch pots, in rich, light soil, and placed in a cold frame or under a wall, where they can be covered with wooden shutters or some similar contrivance to throw off heavy rains. In either case they should be covered a foot thick with newly fallen leaves, and being once well watered after potting they may be left for months to form their roots, when the most forward should be brought out (some repot into somewhat larger pots, according to the apparent strength of the different bulbs), and placed in a gentle heat as near the glass and light as possible to prevent the flower-stems rising to an unnatural height. Some care is necessary in the application of heat, or the flowers will be abortive. It should not exceed 50° for the first three weeks, but afterward may be increased gradually to 60°; and if the pots are plunged in bottom heat the same care should be observed, or the points of the roots will certainly be killed. One-third the depth of the pot is fully sufficient at first, and if the heat is brisk they should not be plunged more than a few inches at any time. When the flower-stems have risen to nearly their full height, and the lower bells of the spike are beginning to expand, the plants should be removed to a lower temperature, usually afforded by the greenhouse, and when the bells are fairly expanded the plants can be taken to the sitting-room, or wherever their presence is desired, observing to protect them from sudden changes or cold draughts of air, and the water given to them should be moderately warm.

Instead of the usual practice of drying hyacinths at once in the sun, I would rather recommend the method adopted in this country, namely, to place them side by side on a sunny spot of ground, and cover them with about one inch of loose earth to thoroughly ripen the bulbs by the subdued heat imparted to the earth which surrounds them. Left in this position for a fortnight, they will become dry and firm, and an hour or two's sunshine will finish them properly for storing.

The propagation of hyacinths can be done artificially in two different ways. (1) By the bulbs being cut crosswise and sprinkled with sand to absorb any superfluous moisture that may exude from the incisions. After a time bulbs thus cut are planted in the usual way, when the parent bulb divides itself into small bulbs. (2) By scooping out the base of the large bulbs after they have been taken out in July. After this operation great attention is needed to watch carefully the process of properly drying the wounded bulbs, because if not properly attended to the whole bulb may become mouldy and be lost completely. Bulbs thus treated are planted in October, at which time the small offsets at the base are partly visible, and are then planted in the usual way, but with only a slight covering of earth in a warm situation as much exposed to the heat of the sun as possible, where the small bulbs gradually develop in the warm sandy soil, with the proper degree of moisture, aided by the climate, which about Haarlem appears to be so very suitable to the growth and development of this flower. (3) In the most natural way by offsets from the parent bulb, which is, however, rather too slow for the present large demand.

Tulips used for forcing require about similar treatment to hyacinths. When placed in heat they should be set as near the glass as possible, in order to prevent the flowers drawing up to high, and the flower stems should occasionally be assisted when by their quick growth they get entangled in the foliage. During recent years tulips have become great favorites for planting in beds, for which thousands are annually employed, making by their very brilliant colors a striking effect.

CALCAREOUS SEA WEEDS.

AT the meeting of the Liverpool Naturalists' Field Club recently, the president (Rev. H. H. Higgins) delivered a lecture on "Calcareous Sea Weeds," illustrated with diagrams and a collection of specimens from the small forms on our own coast to the tinted coral-lines of California, including also a large mass of white stony carbonate of lime, which was once a plant growing on the sea bottom. These plants form a division of Algæ having a rigid stem; nearly all found in salt water, and in almost every latitude. These hard-shelled sea weeds differ physiologically from their softer kinsmen, and thus there ensues a morphological difference. The relation existing between the giant *Sequoia Wellingtonia* of America, which towers to a height of 300 feet or 400 feet, and the tiny crisp sea weed is not superficially apparent, but it exists nevertheless. The old division of the vegetable world into plants, shrubs, trees, or into herbaceous and woody plants, fails entirely now, for the calcareous sea weed is a true plant, and is closely related to the rosy sea weed which is thrown on our shores at times when torn from its home in the deep waters of the sea. Nature is not bound to pattern or to color in working out designs, and so the study of biology becomes the most fascinating of all, and the theory of development is the Magna Charta of our privilege in dealing with nature. The boundless profusion of form in the botanical world and the endless variety of colors justify the use and cultivation of the imaginative and poetic faculties in this study. Stability of a species is necessary to the full development of beauty in the forest and in animal life; and while we recognize the gradual development of life from the protozoan to the highest animal, we can yet see that a modified stability is necessary to the full and complete development of all forms of life. We dwell too much upon the transmutability or variation of species, and in the eager rush after new truth we are apt to overlook the deep, underlying principle of the old one. What we need to-day is a Darwin to follow out the stability of species, which is also part of the doctrine of variability, and which very stability it is which saves us from the atavism and degradation which would ensue from the speedy "survival of the fittest in the struggle for existence." In the beautiful form of the garden tiger moth there is an endless diversity of color, but there is no departure from the true specific character of the tiger moth. So with the currant bush moth; though they vary never so widely, they are ever true to their own species. The entomologist recognizes the tiniest insect, and gives it a name which is known among his fellow students over all the world; and the little speck of an insect, not so large as a pin's head, finds its own mate and reproduces its own kind through all the ages; no variability of species there. From the trilobite and lamp shell of the Palæozoic seas to the great monsters of the Lias times, there is no breach of continuity. Stability of species is as much under law as variation, and plays quite as important a part in the development of life and beauty. The calcareous sea weeds are near relatives of the deep water weeds, but as they came near the shore, where the waters dashed and roared, then came the necessity for a harder coat than when in the quiet waters of the deep, and so they learned to secrete an armor of carbonate of lime. This stiff, brittle, stony matter would not have helped them at all, unless it had been modified to elasticity, and this is admirably shown in the "shepherd's purse coralline," where the armor is short, solid joints forming little triangles, with the apex downward, so that each joint moves freely on the part below it, thus forming a strong jointed armor for the delicate plant body. The massive lime-like form of the *Melobesia* is simply a modification of this same process, by which the tender sea weed has found protection from the dashings of the sea. This development has doubtless occurred in past times, but the modified stability of species keeps them all true to their form. The number and variety of the sea weeds are enormous, but as they have not hitherto been of great economic importance, they have not received the study they deserved; but they are an exceedingly interesting group. During Dr. Hooker's researches into Antarctic flora and fauna, he discovered the famous sea weed which, from the one stem, has floating fronds over 1,000 feet long, in which countless forms of life find food and shelter. The lowly sea weed thus becomes to the plant family what the whale is to the mammals—the overshadowing form of all.

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